MACHINERY.

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AS SEEN BY A DESIGNER.

THE GENESIS OF MACHINE DESIGN, WITH APPLICATIONS.

W. H. Sargent.

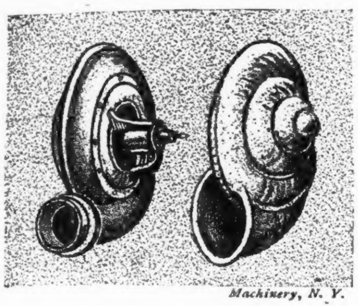


Fig. 1. Applied Zoology.

THERE is a theory that the human mind is like the cylinder to a phonograph, recording indelibly every impression made upon it and capable of reproducing them at will. Sometimes these impressions assert themselves when not called upon and many a speaker or writer has quoted the sayings of others under the delusion that the thoughts were his own. Draughtsmen and designers being human, are alike subject to the vagaries of the human mind. Many times, in designing a piece of machinery, a certain form will persistently assert itself to the draughtsman. Whether this suggestion be perfectly suitable or wholly impracticable, the mind finds itself constantly reproducing some impression made upon it at a previous time, and especially is it true that we unconsciously copy natural objects which often have little in common with the matter in hand.

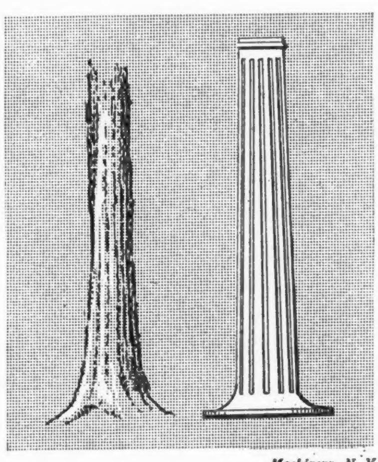


Fig. 4. The Trunk and Pillar.

Influence of Natural Forms.

Take for example, a rotary fan or blower and one is so struck with the resemblance to a snail shell as to warrant the belief that the designer was familiar with such shells and has recognized the suitability of the design as a guard to cover delicate and easily injured parts. There could hardly be greater contrast than between the swiftly revolving fan and the slow moving snail, yet it is difficult to resist the impression that the shell had somehow unconsciously influenced the mind of the designer. This resemblance is shown in Fig. 1.

For convenience in use, machine tools must be mounted at a certain height above the floor and the intervening space filled in with something which, as Abraham Lincoln said of his legs, "should be long enough to reach from his body to the floor." Now, I have many times heard draughtsmen say that the hardest thing to design about a machine was a suitable leg. The reason is obvious—a leg is inappropriate, a support is what is needed. We get the idea of legs from the animals which we see about us every day, forgetting that these legs are used for traveling rather than for standing still. Such legs may not be so inappropriate for furniture or movable articles as for a machine tool which should be the very embodiment of stability. Here again the doctrine of unconscious suggestion appears in the resemblance to the legs of some animal as the horse, Fig. 2. The double curved "bandy" leg may still be acceptable on chairs, cabinets or pianos, but on machine tools it is being replaced by a more rigid support in which the idea of a leg is quite abandoned, one of the most popular and appropriate styles being the cabinet, Fig. 3.

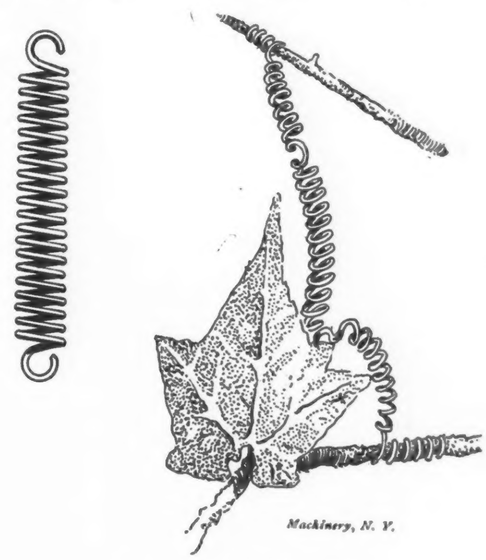


Fig. 5. Origin of the Spiral Spring.

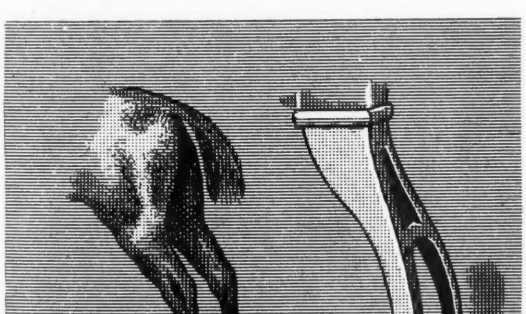


Fig. 2. Horse Legs.

Fig. 3. "Horseless" Legs.

Pillars are usually admissible in machine design and here again the idea is suggested unconsciously, a pillar being the conventionalized form of a tree trunk, the flutes in the pillar being

modified from the ridges of bark and the curving base being caught from the spreading of the roots, Fig. 4. The tree trunk is made to stand and is designed to support something and is therefore a logical model to follow when these qualifications are desired. The pillar lends itself well to architectural purposes and has been fluted and decorated to a point not permissible in machine design.

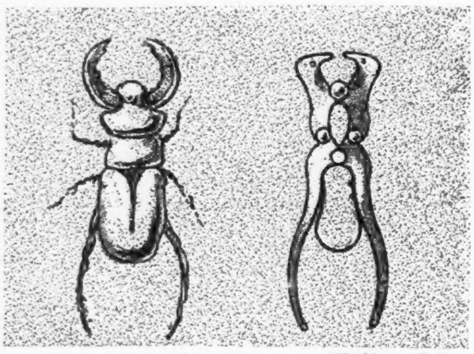


Fig. 6. Nippers.

Who invents all the little simple appliances of everyday life? Many of them are adapted by human nature from nature itself. Pins and needles we get from the thorn tree; perhaps the first fish-hook was a herring bone. Look at the coiled spring! It was old when Moses was a boy. Go out into the garden and watch for them on the squash vines. Examine one closely and you will notice that it is not only coiled, but coiled two ways with a device in the center for reversing the twist, so that with one end growing from the stalk and the other attached to a twig it may still continue to twist. Here is an unpatented idea which might perhaps be profitably employed in mechanics. Note the reversed twist in Fig. 5.

The nippers of some varieties of beetles might have suggested the cut-nippers of the shop (see Fig. 6) and other in-

Fig. 7. Testing the Strength of an Egg-shell

sect workmen might teach us secrets in the arts of the weaver, paper-maker, plasterer or mason. We speak of a suspension bridge as a "spider's web," but really the bridge builder "isn't in it" as compared with the spider. His is the

"Knowledge never learned of schools,
For, eschewing books and tasks,
Nature answers all he asks."

Perhaps you say, "these things may be all very interesting, but what can we learn in relation to machine design?" Anybody who knows enough can learn something from somebody else. Can you make a column of steel as strong, weight for weight, as one of oat straw? Can you design a dome which, with the same economy of material, will resist as great a crushing load as a hen's egg? Perhaps you don't know how strong a hen's egg is. I don't mean a bad egg, either. Hold one between the palms of the hands as shown in the cut and, with the fingers locked together, try to crush it by pressing on the two ends of the egg. Then take a handful of chalk and make one. Perhaps, instead of being a designer, you are interested in the economy of management. "Go to the ant, consider her ways and be wise."

The influence of natural forms extends even to the names of shop tools, simply because the form or the purpose reminds us, unconsciously, perhaps, of some familiar form of natural life. A monkey wrench with the slide moving up and down the handle resembles a toy monkey running on a yellow stick, while the grinning jaws of the saurian undoubtedly made him godfather to the alligator wrench. We hear a blacksmith speak of a "snibel," meaning a hook and short piece of rod not unlike a snipe bill in shape and a crane is called a crane because, as the Dutchman said, "dat ish hees name."

Theory.

It will be said that the foregoing is mere "theory" without any practical bearing on shop practice, and the theoretical person is regarded as one who indulges in useless refinements of

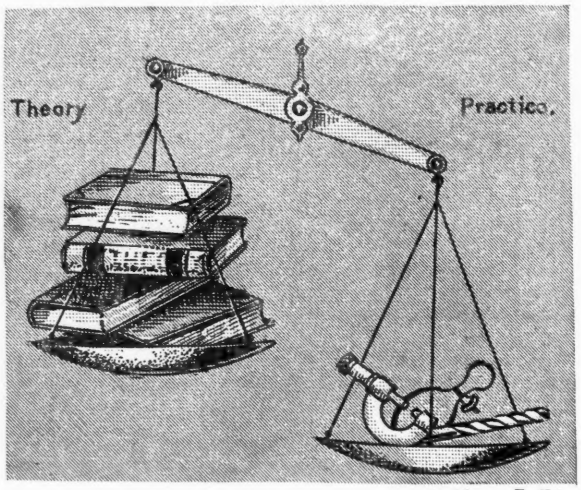


Fig. 8.

any nature as compared to the practical man who accomplishes something. Practice has been defined as "what we know," and theory, "what we do not know." Many sneers have been aimed at school draughtsmen and much amusement has been derived from the idea that "book learning" could be profitably employed

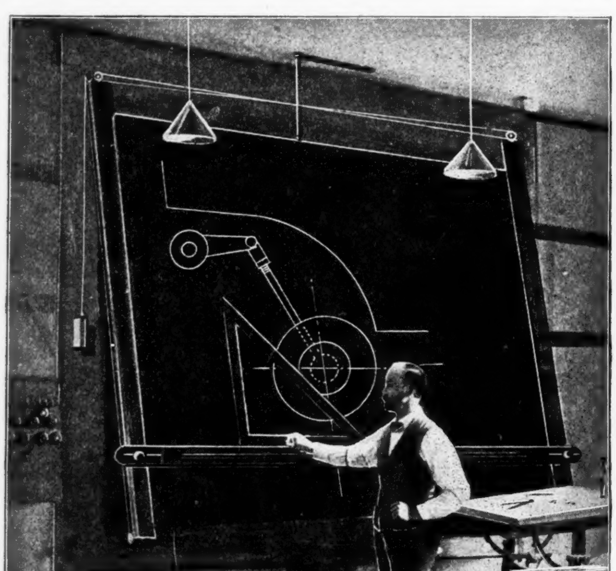


Fig. 9. Drafting-office Blackboard.

in the shop. Much that has been learned in schools and from books or from nature must be unlearned before the student can make successful headway in shop designing; but, owing to his school training, he learns over again so easily that he can well afford to do so and even then compete with the "practical" man who has had only shop experience to guide him. The theoretical man has learned how to do a thing, while the practical man

does it, and between the two is a great gulf fixed. To the student it seems as if the chief end of the designer was to make a satisfactory drawing while to the mechanic the drawing is only a means to an end. It is necessary first to get rid of the idea that mechanical drawing is an art. It is a means of expression the same as writing and a competent designer need not be an artistic draughtsman any more than an author or an editor need be a

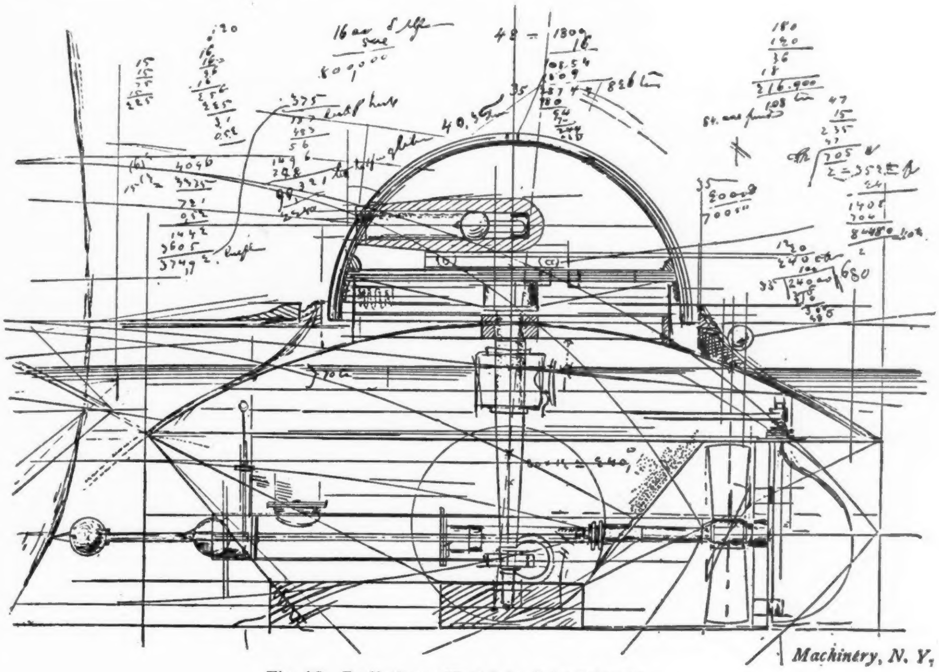


Fig. 10. Preliminary Sketch by John Ericsson.

skillful penman. The real skill lies in expressing one's meaning clearly and distinctly and is the skill of the mind rather than of the hand.

Practice.

It is impossible to give a formula for a satisfactory design for a machine, a tool or any industrial appliance. It is the practice in some shops to have a large vertical blackboard so arranged as to be raised and lowered and, on this, to sketch out in crayon a full sized drawing of the machine or of the part in question. See Fig. 9. A council of experts may now "sit" upon it and any

Fig. 11.

suggested changes be easily made in crayon. Other designers go to the opposite extreme and make a series of small sketches, perhaps quarter size, which are easily examined and readily passed around for criticism and from these a full sized drawing may be worked up embodying any suggested changes. There are usually certain unalterable conditions, certain parts which cannot be changed. There are gears and cranks and pulleys which must bear a certain fixed relation to each other and these should be drawn in at once. Mark each such part, its size and its function, "12" driving pulley 4" face, hand lever operating cam," and mark the turning direction of all revolving parts. This will give you a skeleton which you are required to clothe. You are expected to supply head, body and legs all out of your own imagination. As the chap said who made a wooden clock, "made it all out of my own head and have wood enough left to make another."

Having well in mind what your machine is expected to accomplish, begin work on your drawing. "Get a move on you." Sketch something. Draw a center line and build your drawing around this. Lay out the greater dimensions, the limiting conditions; let the details wait. Get some lines on the paper and it will cease to stare at you. Block out the general shape somewhat, as shown in Fig. 10. Proportion the various parts about as you think they should be and let the computations go for a little. Ask an experienced designer how he arrives at the various proportions and he will tell you "horse sense," but it is really by bitter experience derived from many errors in the past. It was "horse on him" all right.

By this time you have found out that your drawing isn't what you thought is was going to be; you have run into a "snag." Very well, begin again. Don't try rubbing out unless you see clearly what you are going to gain by it. Paper is cheap and it is no disadvantage to have several sketches on hand, "studies," the artists would call them, and it sometimes happens that the first sketch proves the most available in the end.

Detail Drawings.

Leave the general drawing about in this stage and make detached detail sketches of the different parts, especially where interferences are looked for, and it is safe to take a good look on purpose for them. Take the machine apart, as it were, and test every member not only for strength, but for appearance as well. Dimension every part and fit them back into the original design. As fast as you are sure of a part, ink it in. Carry along the assembled drawing and the details at the same time, especially at all points where unusual difficulty arises. The usual tendency, especially in cast iron, is toward unnecessary weight. The design looks smaller on paper than it feels in solid iron. Remember also that castings have a trick of coming closer together in the machine than they show on paper.

Mathematical Refinements.

It will be necessary to make some calculations to determine the sizes both of the working parts and of the frame and supports, and the design may have to be modified to reconcile the changed conditions. Commercially, it does not pay to figure too fine where cast iron is so cheap. The metal must be put in the line of force and given such shape as has been found to offer the greatest resistance to the various stresses; round, like a shaft, for torsion; a T shape for tensile stress and curves for members subject to bending action. Formulae for most of these are usually at hand which one can readily apply even if he does not know how they were obtained. We are obliged to

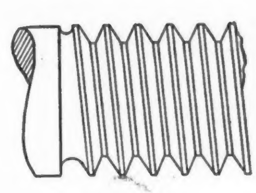


Fig. 12.

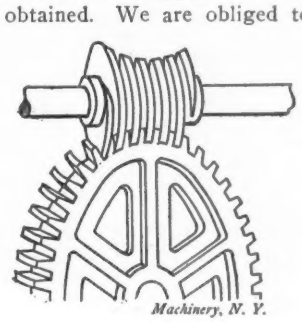


Fig. 13.

take for granted the accuracy of other tools without knowing how they were made; why should it be necessary to compute a formula before we are allowed to use it? It is not knowledge itself, at this "stage of the game," but the commercial application of it which enables one to make the best and most economical design.

"As Easy as an Old Shoe."

We all know how much easier an old shoe is than a new one, not necessarily a worn-out shoe, but one which has been well broken in; and, as in shoes so in machinery. A machine runs better, feels better and does better work after the "new is worn off" and the obvious lesson from this is to so modify our design as to represent our subject when worn to the greatest stage of usefulness, in other words, "broken in." Squeeze a ball of stiff putty in the hand and it will take on the general shape of a handle, as shown in Fig. 11, but showing every mark and crease of the fingers. It fits the hand too exactly for a handle; as the small boy said, "it's too fit." Smooth off all the sharp ridges about as the handle would wear after being in use a considerable time, but without changing the general contour, and we have a well feeling handle. The most popular screw-thread to-day is the U. S. Standard, Fig. 12, which is, after all, only the ordinary V thread worn down. It has been "broken in." The Hindley worm gear, Fig. 13, might be quoted as an illustration of this theory, as both the worm and the gear have the appearance of having been run together until each has worn the other down to a perfect bearing.

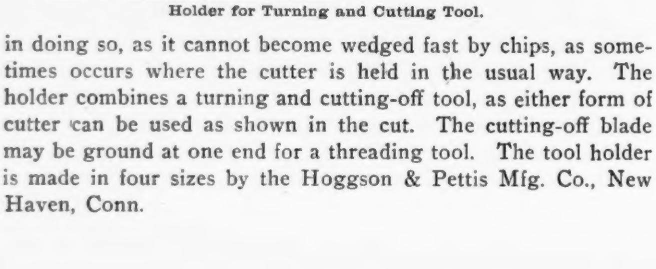
All sharp corners should be rounded about as they would wear off in actual use and this applies not only to castings, but to most machined surfaces, especially such as are to be handled. Nothing offends a critical purchaser more than to pick up a finished tool and feel the burr on the edge. It sets the shivers running down one's back until the "chill is taken off" by rounding the corners.

All ideas are new but once, no one can originate everything. A designer is seldom called upon to make a design for an absolutely new machine. It usually resembles some existing mechanism to some degree, enough to give him some idea of the treatment. It is not always safe, however, to follow even the nearest existing model. The first passenger car was built like a stage coach because of the similarity of purpose; and we are to-day making horseless carriages by simply leaving off the horse, but it can hardly be possible that the best designs for an automobile can be had in this way. That which shows itself well adapted to the purpose is retained and used over and over again until it comes to be the accepted form. It can hardly be said that such designs are copied; they are inherited. As for copying designs in their entirety, it is difficult to distinguish this from any other kind of stealing. Some one has paid for the time and brains and experience necessary to produce an attractive design and the Government recognizes this fact by providing means for protecting the designer by a patent which has a larger scope and a longer life than an invention patent.

* * *

A COMBINATION TOOL HOLDER.

The tool holder shown in the accompanying cut is somewhat different in its construction from the usual styles. The cutter is not held by the point of a set-screw, but is held to the side of the holder by a clamp having a set-screw on the opposite side from the cutter. The cutter is thus firmly held to the holder without scoring by the point of the screw or without danger of breakage. When the cutter is to be released there is no trouble



Holder for Turning and Cutting Tool.

in doing so, as it cannot become wedged fast by chips, as sometimes occurs where the cutter is held in the usual way. The holder combines a turning and cutting-off tool, as either form of cutter can be used as shown in the cut. The cutting-off blade may be ground at one end for a threading tool. The tool holder is made in four sizes by the Hoggson & Pettis Mfg. Co., New Haven, Conn.

NOTES FROM A WELL-KNOWN SHOP.

WITH ILLUSTRATIONS OF GEAR-CUTTING MACHINERY.

The works of Gould & Eberhardt, Newark, N. J., which have been a landmark for many years in that vicinity, have recently lost their familiar appearance. The old walls at the front and sides of the main building have been torn down and new walls with large windows have been built, the style of architecture following closely that used in mill construction. Inside, the changes are not so marked, but another story has been added; advantage was taken of the opportunity to strengthen all the floors; electric lighting has been introduced and to some extent electric driving. The rooms of the building are lower studded than would be the case in a newer building, and the arrangement of the incandescent lamps is well adapted to these conditions, where head room is at a premium. Tin reflectors are used in the shape of an inverted trough, perhaps 30 inches long by 12 inches wide and attached to the ceiling between the floor beams at suitable intervals. These reflectors are lined with strips of looking-glass and contain three incandescent lamps each, which shed the light over a considerable area.

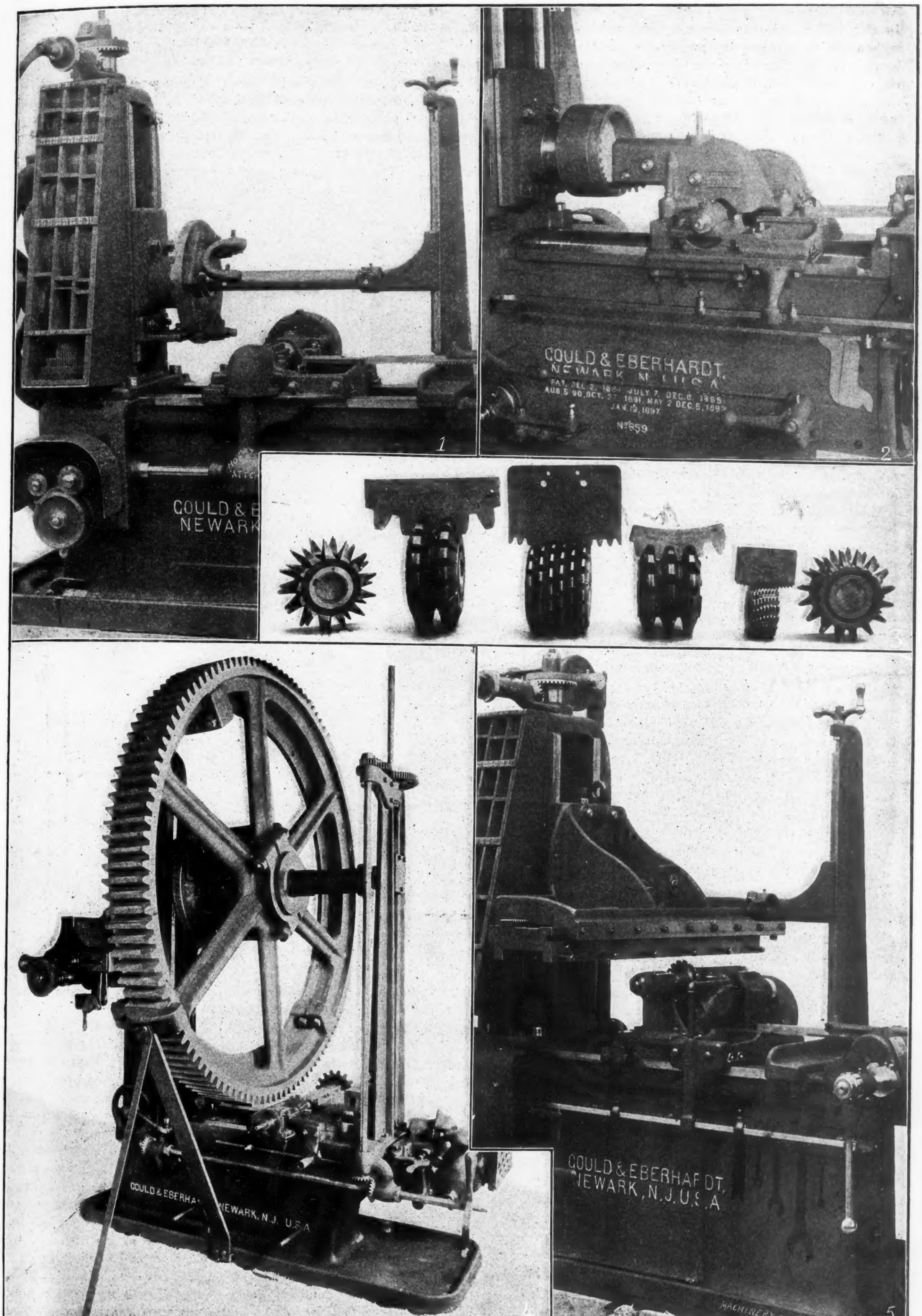
It is interesting to note that this building is the one in which Ezra Gould, the founder of this business, first had quarters for his machine shop fifty years ago. It was here, also, that Mr. Eberhardt learned his trade in the employ of Mr. Gould. The latter had been with the locomotive works at Paterson, N. J., but when he moved to Newark he engaged in the machine tool business, which has been the work of this shop ever since. He was one of the first to build milling machines and gear cutters in this country, and it is probable that, as many of the tools used at Paterson at that time were of English manufacture, he was influenced somewhat by English designs. However that may be, it is a singular fact that his machines differed in some important particulars from those built by most of the older firms. For example, the dividing mechanism of his gear-cutting machines was a worm and worm wheel such as is used on all gear cutters at the present time, while the general practice of the day was to use the index plate for spacing. We have at various times illustrated early gear cutters, which in nearly, if not quite every instance, had the index plate in which holes for spacing were drilled.

Mr. Eberhardt came to this country from Switzerland, and besides learning the machinist's trade had also to learn the English language, which he did at evening school; but in spite of this drawback he was later promoted to the position of foreman and shortly afterwards obtained an interest in the business, which thenceforth went under the firm-name of Gould & Eberhardt. About fifteen years ago Mr. Gould retired, but he is still living, and although very aged occasionally pays a visit to the works. The first machine that Mr. Eberhardt worked upon when starting as an apprentice was a gear cutter, and at the time of the writer's visit this same machine was doing duty as a drill press, drilling holes in the rim of a wheel.

On page 197 are a number of illustrations made from photographs that were selected from a large number that have been taken to show the character of the work and products of this company. About two years ago a new type of gear cutter was brought out, called the "Victoria," which many of our readers will remember we illustrated at that time. In this machine only one belt and pulley are used for driving, and the different movements are operated by spiral gears and splined shafts, which provide for the motion of the various slides. Since that time a number of attachments have been brought out for this type of machine, all of which are entirely automatic in their action. These are shown in the group illustration, together with two other photographs that we think will interest our readers.

In Fig. 1 is the machine with the hobbing attachment, which will hob the teeth of a worm wheel automatically without first nicking the blank. The wheel blank is placed on the work arbor, as is usual, and the hob on the cutter arbor, when the two are made to revolve in unison through the connections with the dividing mechanism which are plainly visible in the illustration, while at the same time the wheel is fed down against the hob.

In Fig. 2 is an attachment at work cutting an internal gear, and the cutter is in this case driven by a train of spur gears, the



MODERN PRACTICE IN GEAR CUTTING.

last gear of the train gearing into a pinion on the cutter arbor. In Fig. 5 is a rack-cutting attachment, consisting of a bracket with a sliding carriage for supporting the rack and a raised bearing for bringing the cutter above all projections of the carriage, so that a rack of any length can be cut. It will be noted that with all these attachments the ordinary carriage that is used for cutting spur gears is made use of.

Fig. 3 is from a photograph taken of several sets of gangs of cutters that are peculiar in that they are so formed that they will cut and finish at one operation two or more teeth of a gear. Thus, the two cutters at the left will finish two teeth at a time, the next six teeth at a time, etc., and when the gear is rotated for a new pass of the cutters, it must in the one case be moved a distance of two teeth, and in the other a distance of six teeth. It is a little puzzling at first to see how this result can be accomplished, since all the cutters are on the same arbor. It is done by so shaping the cutters that the teeth of each individual one will point toward the center of the gear; that is, if a cross-section were taken through the cutters, it would be found that the center lines of the teeth shown in section were radial lines from the center of the gear blank. The outer cutters of each gang are of larger diameter than the inner ones, to conform to the curvature of the gear, and as one set of cutters is theoretically correct for one diameter of gear, their use is limited to the manufacture of gears of the same diameter and pitch that are to be made in large quantities. The cutters at the ends of the photograph show to what an extent it is possible to sharpen correctly formed cutters and still have them retain their shape.

In some respects Fig. 4, is the most interesting one of the group. It is the first one of this new type of machine in which the spiral drives are used, and it is at work upon a wheel of unusual size, showing what is now posible in the line of ordinary practice in gear cutting. The wheel being operated upon is 8 feet 1.6 inches in diameter, 9-inch face, and has a hole through the hub 10 inches in diameter. The blank weighed over three tons before cutting. The teeth are 2½ inch circular pitch, and about 600 pounds of metal were removed in cutting.

An improvement that has recently been added to these machines is an automatic rim clamp that, when once adjusted, will automatically clamp the rim of the blank before the cutter begins its work and automatically release before spacing occurs. The movement of the clamp is governed by an eccentric connected with a shaft that drives the indexing mechanism and thus has an intermittent motion every time the gear is to be spaced.

* * *

In reporting the exhibits at the Philadelphia Commercial Congress, the "Philadelphia Record" mentioned several exhibits of iron articles which showed a beautiful dull black surface that was very attractive for such work. "Sparks" gives this explanation of the process as contained in the "Record:"—

It consists in coating the objects very uniformly with a thin layer of linseed oil varnish, and burning it off over a charcoal fire. During the deflagration the draught must be stopped. The varnish will first go up in smoke with a strong formation of soot, and finally burn up entirely. The process is repeated, *i. e.*, after one coating is burned off a new one is applied, until the parts exhibit a uniformly handsome, deep black color. Next, wipe off the covering with a dry rag, and heat again, but only moderately. Finally the articles are taken from the fire and rubbed with a rag well saturated with linseed oil varnish.

TESTING THE STRENGTH OF MATERIALS—2.

ROPE TESTS.

EDWARD F. MILLER.

To test the strength of a rope, a tension machine capable of holding a long specimen is required. A simple machine of 30,000 pounds capacity, like that shown by Fig. 1, can be made at a moderate expense. The machine shown can be used for tension work only. The frame and uprights are of 6"x6" hard pine. The pulling screws are of sufficient length to give a motion of 4½ feet to the pulling yoke. The weighing system is quite simple and can be readily followed out in the cut. One

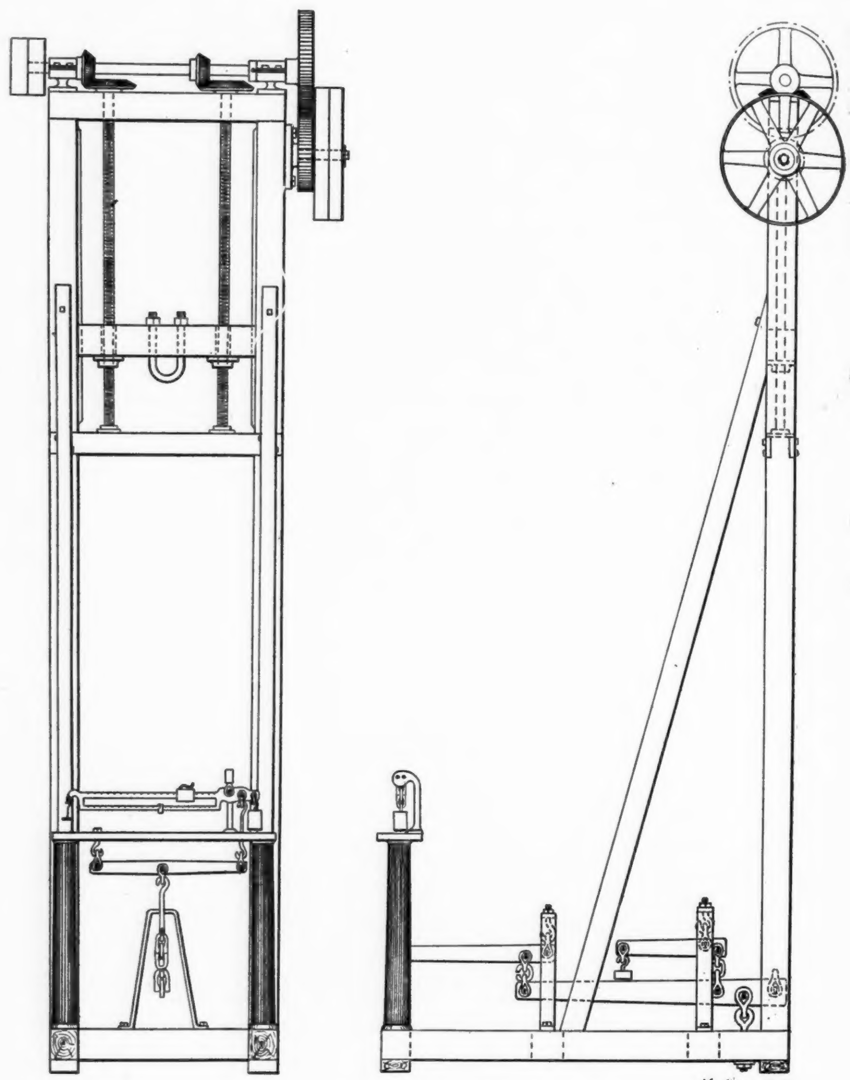


Fig. 1. Rope-Testing Machine.

end of the specimen of rope is attached to a yoke in the block moved by the screws and the other end is fastened to the loop in the end of the main lever of the weighing system.

The greatest difficulty in testing rope is in attaching the ends of the specimen to the machine so as not to have the rope break at the fastenings. The most satisfactory method is to attach by an eye splice at each end of the specimen. Before testing, the splices are soaked in water for 10 or 12 hours in order to harden them. The rest of the rope is not wet. If a knot is tied in a rope, failure is sure to occur at that place. A few tables of tests follow. In some of these the efficiencies of the different knots shown by the cuts have been figured. These tables are interesting, as they show the strength of rope is reduced nearly 50 per cent. by some of the knots commonly used. This loss of strength is due to an injury to the fibers on the pulling part of the rope, caused by a cramping in the knot.

The stretch of new rope under a gradually applied load is given in the following table. These figures are the means of a good many observations. The power end of the testing machine moved at the same rate per minute in all of these tests; hence the time required to obtain a certain load will be greater the

greater the stretch. About 10 minutes were required to load the manila or hemp ropes to 4,000 pounds and about 18 or 20 minutes were required for the cotton rope. The cotton rope is sold by the diameter and the hemp and manila by the circumference except in the case of transmission rope. The ⅞" cotton rope is about 2¾" in circumference. A comparison of the

TESTS ON THE STRETCH OF ROPE.

Loads.	Total Stretch per Foot.			
	2½" Manila.	2½" Russian Hemp, tarred.	2" Manila.	⅞" Dia. Cotton.
	Ft.	Ft.	Ft.	Ft.
500	.043	.058	.031	.097
1000	.070	.080	.052	.136
1500	.090	.095	.067	.164
2000	.105	.105	.080	.187
2500	.119	.114	.090	.205
3000	.130	.121	.099	.224
3500	.138	.126	.107	.240
4000	.146	....	.114	...

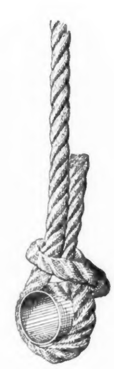
stretch of the ⅞" cotton with the 2½" manila or hemp shows that the stretch of the cotton is nearly double that of the others. The manila and hemp rope were purchased of the Plymouth Cordage Co.





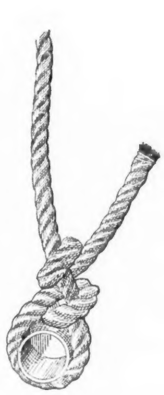
Machinery, N.Y.

Fig. 2. Fig. 3. Fig. 4. Fig. 5




Machinery, N.Y.

Fig. 6. Fig. 7. Fig. 8.

Machinery, N.Y.

Fig. 9. Fig. 10. Fig. 11.

The preceding illustrations show the kinds of knots that were used in the tests, of which summarized results are given in the following table. The names of the knots are as follows: Fig. 2, open-hand knot; Fig. 3. square knot; Fig. 4, Englishman's tie; Fig. 5, ordinary tie; Fig. 6, plain slip knot; Fig. 7, Flemish loop; Fig. 8, timber hitch; Fig. 9, bowline; Fig. 10, double half hitch; Fig. 11, eye splice.

TENSION TESTS ON ROPE *

Number of feet per pound.	Number of Turns of One Strand per foot.	Location of Breaks.	Average Strength, lbs.	Efficiency of Knot or Splice.	Method of Holding.
2½" MANILA ROPE.					
5.	5⅓	At center.	5,420	100	Spliced eyes over iron eyes.
5.4	5⅔	At knot	4,280	79	Held at each end by a timber hitch knot over a 2" pipe coupling.
5.6	5⅓	At knot	3.750	69	Held at each end by a double half hitch knot over a 2" pipe coupling.
5.3	5⅓	At knot	3,520	65	Held at each end by a slip knot over a 2" pipe coupling.
5.3	5⅓	At knot	2,880	53	Bowline knots over iron eyes.
5.5	5⅓	At knot	2,500	46	Flemish loops over iron eyes.
2" MANILA ROPE (THREE STRANDS).					
7.5	5½	At center	4,760	100	Eye splices at ends over iron eyes.
7.4	5½	At knot	3,140	66	Timber hitches at ends over 2" pipe couplings.
7.4	6	At knot	2,840	60	Bowlines at ends over iron eyes.
7.4	6	At knot	2,090	44	Flemish loops at ends over iron eyes.
7.2	6	Middle knot	2,910	61	Joined at middle with Englishman's knot. Held at ends with timber hitches.
7.2	6	Middle knot	2,700	57	Joined at middle with ordinary tie. Held at ends with timber hitches.
7.3	6	Middle knot	2,480	52	Joined at middle with square knot. Held at ends with timber hitches.
7.1	6	Middle knot	2,180	46	Joined at middle with open hand knot. Held at ends with timber hitches.
2½" TARRED RUSSIAN HEMP ROPE (THREE STRANDS).					
4.4	5½	Near center	5,250	100	Spliced eyes over iron eyes.
4.3	6	At knot	3,790	72	Timber hitches over 2" pipe couplings.
4.5	6	At knot	4,140	79	Slip knots over 2" couplings.
4.[illegible]	5½	At knot	2,980	57	Bowline knots over iron eyes.
4.5	6	At knot	2,810	54	Flemish loops over iron eyes.
2½" RUSSIAN HEMP ROPE.					
5.5	5⅓	At center	6,580	100	Spliced eyes over iron eyes.
5.4	5½	At knot	5.100	78	Timber hitches over 2" pipe couplings.
5	5	At knot	5,020	76	Slip knots over 2" pipe couplings.
5.1	5	At knot	3.920	60	Bowline knots over iron eyes
5.1	5	At knot	3,550	54	Flemish loops over iron eyes.

* * *

PATENT OFFICE RESOLUTIONS.

At the Washington meeting of the American Society of Mechanical Engineers, held last spring, resolutions were passed urging upon Congress the necessity for legislation leading to the relief of the present overcrowded condition of the Patent Office, and providing sufficient room, force and facilities for the proper execution of its work. The secretary of the society has recently sent a copy of the resolutions to the different members with suggestions for helping the cause and with a statement of some of the difficulties under which the Patent Office is laboring.

The Patent Office, by virtue of its being one of the many bureaus in the Interior Department, has had to contend with a species of rivalry or discrimination, with the result that, by reason of the continued growth and progress of the departmental work, the storage capacity of available areas has been crowded to the utmost. In some cases the weight of papers has reached a point at which further storage upon the floors is forbidden by the building inspectors, with the result that records which are titles to valuable manufacturing properties are crowded into passage ways and elsewhere, where they are not only exposed but where, in case of accidental fire, they could not be saved. Up to the 1st of January, 1899, 693,979 patents had been granted and 41,422 trade-marks, labels, etc., had been registered. Last year 25,527 patents were granted, and 2,260 trade-marks registered. This accumulation has forced the galleries of the halls, originally designed for models, to be crowded with record matter and the exhibition of models has been congested and made practically impossible. With respect to the library of the Patent Office, with its two departments of Science and Law, less than $1,500 was available this year for the purchase of books for the scientific library, and no funds whatever were available for the law library.

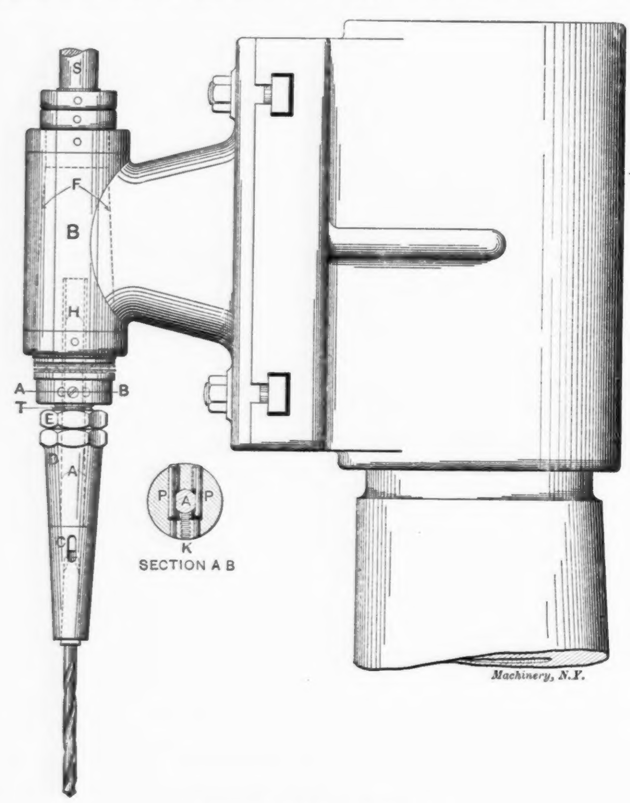
*[This table gives approximately average results taken from a more extended table furnished by the author.—EDITOR.]

MULTIPLE SPINDLE DRILL.

A multiple-spindle drill with 34 spindles is shown in the accompanying illustration. In this particular case the machine is intended for drilling the holes in the cutter bars for reapers, but the same design is used for any class of work requiring a large number of holes to be drilled in a row. The rail supporting the bearings for the spindles is carried by five columns and power is transmitted to the spindles through the bevel gears, seen at the top, and the universal joints which allow for adjustment of the spindles to the right or left. Thirty-one of the spindles are for 5/16" drills, two for 13/16" drills and one for a ⅝" drill.

The table, which is supported by knees working on slides in the columns, is operated by three heavy screws which receive motion from the horizontal shafts running lengthwise of the base of the machine. This feed motion is designed to give a slow feed with a quick return by power and a stop motion is provided, so there is no likelihood of accident through feeding too far. When drilling, the table feed-screws are driven by worms and worm-gears, and when it is desired to move the table rapidly in either direction, the screws supporting the table are operated by spiral gears.

Referring to the lower part of the illustration, it will be observed that there are two feed shafts, and also one driven by a worm and worm gear from the main driving shaft at the left. On the lower shaft are the worms that drive the feed-screws when drilling. At the left end of the upper shaft are a clutch and two spur gears, one of which receives motion from the lower shaft directly and the other receives motion through an intermediate pinion which causes it to revolve in a direction opposite to that of the first wheel. Hence, by throwing the clutch one way or the other, the upper shaft can be driven in

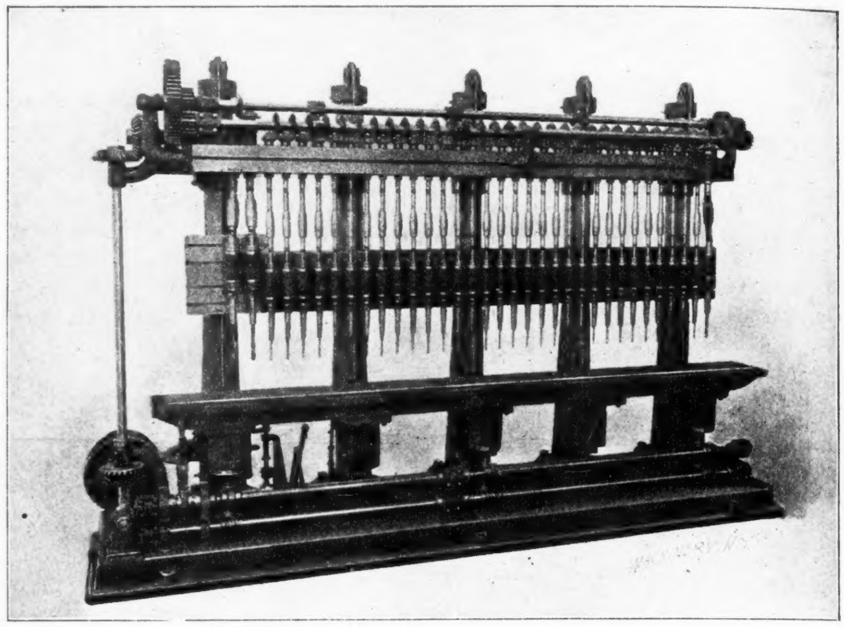


Details of Spindle and Head.

either direction and it in turn will drive the feed screws rapidly in either direction through spiral gearing which is plainly visible on this shaft at each of the three feed screws.

There are also clutches on the feed screws, all operated by one lever, which are so connected that it is impossible to throw in both the slow and fast feeds at the same time.

In the line drawing, Fig. 2, are the details of one of the heads of the machine. It is obvious that the drill spindles should be so adjusted that all the drills will commence to enter the work at the same time. Referring to the sketch, S is the spindle and B the bearing with a taper bushing, F, for adjustment. The spindle proper extends below the bearing and is threaded, as



Drill with Thirty-four Spindles.

shown at T to fit the long nut D and the check-nut E. The collet C, in which the drill fits, has a long shank and extends into the spindle for a considerable distance, as indicated by the dotted lines. This shank is round and fits accurately in the hole in the spindle. Two sides of the upper part of the shank are flattened, as shown in the sectional view, and bear against two flattened pins, P P, which take the torsional strain of the drill.

If it be desired to lengthen the drill spindle, the set-screw K holding the drill collet in place is loosened and the drill lowered the required distance. The nut D is then screwed down until it bears against the shoulder on the collet and is locked in place, when the drill will have a solid support to take the thrust, and will be driven positively by the flattened pins.

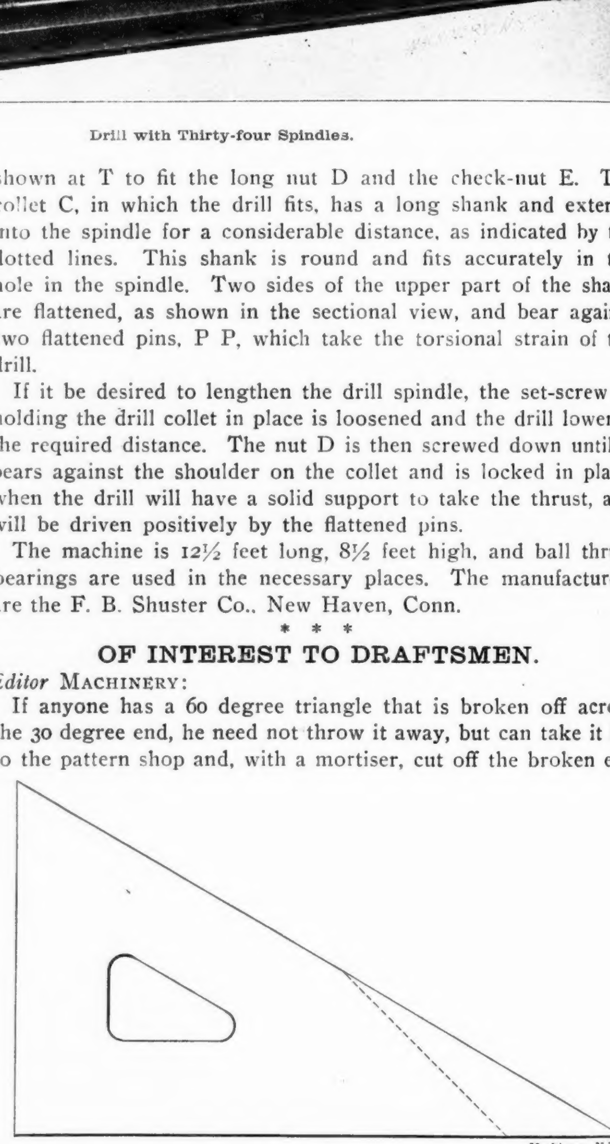
The machine is 12½ feet long, 8½ feet high, and ball thrust bearings are used in the necessary places. The manufacturers are the F. B. Shuster Co., New Haven, Conn.

* * *

OF INTEREST TO DRAFTSMEN.

Editor MACHINERY:

If anyone has a 60 degree triangle that is broken off across the 30 degree end, he need not throw it away, but can take it into the pattern shop and, with a mortiser, cut off the broken end



To Save a Broken Triangle.

at an angle of 45 degrees, as shown by the dotted lines in the accompanying sketch. It is surprising what a useful tool it makes for the drawing-board and I am surprised that such a triangle is not made for the trade. A. W. DRAESCH.

METHODS OF CONTROLLING DIRECT CONNECTED MOTORS.

Wm. Baxter, Jr.

The stationary electric motors used at the present time are almost invariably of the constant potential type, that is, they are so made as to be operated by the current furnished by incandescent lighting companies. Alternating current motors are coming into use slowly but are not likely to become common for some time to come, hence, this article will be confined to the first named type.

Constant potential motors are made with three different styles of field winding. The simplest is known as the series motor, the next in order as the shunt motor, and the last as the differential, or compound wound motor. The series winding is used for cases where it is not desired to run at a constant speed, and also where the power required is constant, in which case the motor speed will be constant. As examples of the latter kind of service we may mention the operation of blowers and pumps that raise water against a given head or uniform pressure. As examples of variable speed cases we may mention hoisting machines, printing presses, lathes, etc. Variable speed work can also be performed by motors of the shunt or compound type, and these are used for such cases, and as a rule they are more desirable, from the fact that, if provided with a suitable regulating switch, they can be made to run at a constant velocity when required, regardless of changes in the load thrown upon them. This result cannot be accomplished with the series machine. In all cases where a constant speed is required all the time, the shunt and compound motors are the only ones that can be used.

Every type of constant potential motor, with the exception of the commutated field series machine, requires a starting rheostat, and if the speed is to be varied after the machine is in motion, then in addition, a regulating switch is necessary. This regulating switch is commonly called a controller. The starting rheostat is simply a resistance that is placed in the circuit of the motor armature in the act of starting, so as to keep the current strength down to reasonable limits; and in the case of the shunt

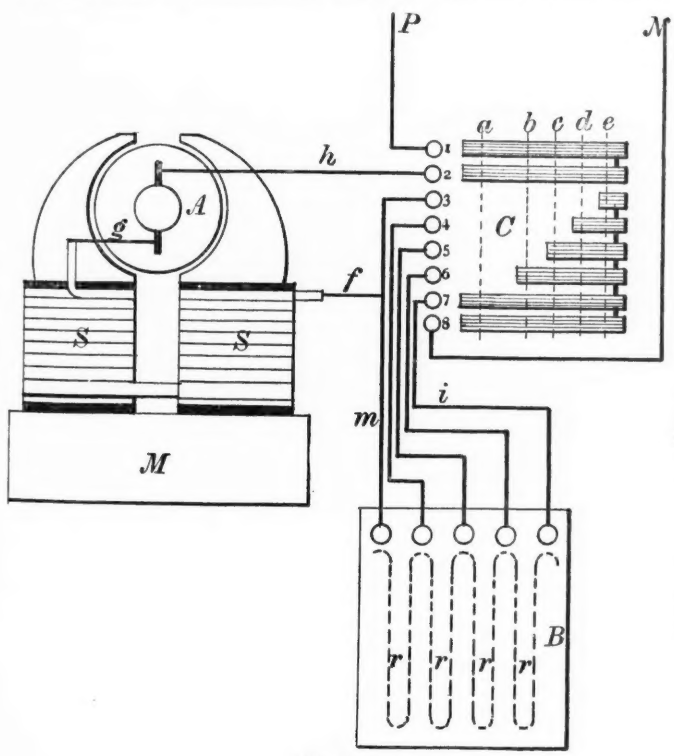


Fig. 1.

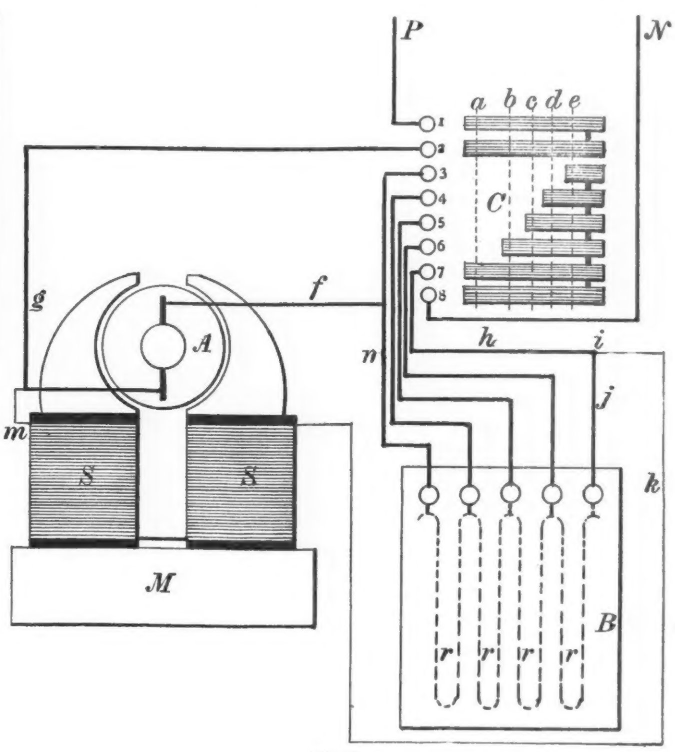


Fig. 3.

motor, also, so as to enable the machine to start with a load. The starting rheostat is generally so constructed that after the motor has been set in motion, the switch is held in position by the attraction of a magnet, or by a catch; but at any time thereafter if the current strength rises to a point that would endanger the machine, the switch is released and immediately flies back to the stop position and thus cuts the current off. Starting rheostats of this kind are used with all types of motors, that is, with the series, the shunt and the compound, where manual speed regulation is not required when the machine is in service. When it is desired to regulate the velocity, manually, the starting rheostat is generally discarded, and a controller is provided that performs the office of motor-starting rheostat, as well as that of speed controller.

The diagram Fig. 1 illustrates a controller used with series wound motors, which is known as the rheostat type. The manner in which this switch is connected in the circuit is illustrated

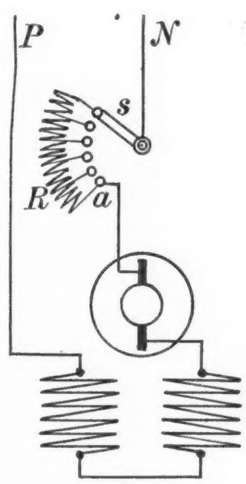


Fig. 2.

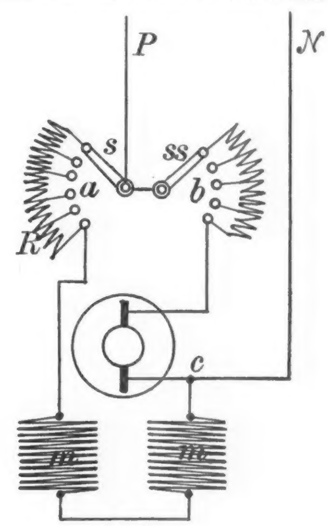


Fig. 4.

in Fig. 2. When the motor is started, the switch is in the position shown in the latter figure, and thus cuts into the circuit all the resistance of the rheostat. As the speed of the motor increases, the switch is moved downward, and when full speed is attained it rests in the lowest position, that is, on contact a. This is also the way in which an ordinary motor starting rheostat acts, and that is the reason why this type of controller is called rheostatic. The difference between a motor starter, and a rheostat controller is that the first is made so as to be locked in its final position and to be released by the current, while the latter is not locked in any position and can be set anywhere at the will of the operator. Another difference is that the starter is made of much smaller current carrying capacity. In a motor starter the resistance is traversed by the current for only a few seconds, in the act of starting, therefore the heat generator in it is small and can be dissipated by an apparatus of small dimensions; but a motor controller must be of such size that it may be traversed by the current all the time without being overheated.

A motor starter has to be moved only when the machine is started and stopped, therefore, the switch part can be made in the form indicated in Fig. 2; but a controlling switch has to be moved frequently, sometimes every few seconds, hence, the switch part must be strong and capable of withstanding any amount of rough usage. In the design of controller most commonly used, there is a vertical row of contacts to which the terminals of the motor armature, the field coils, the resistance sections and the line wires are attached. These contacts are so placed that they press upon the surface of a cylinder which has its surface covered with contact rings of such length and so joined with each other, that the necessary connections of the various terminals are made as the cylinder is turned from one position to another. In

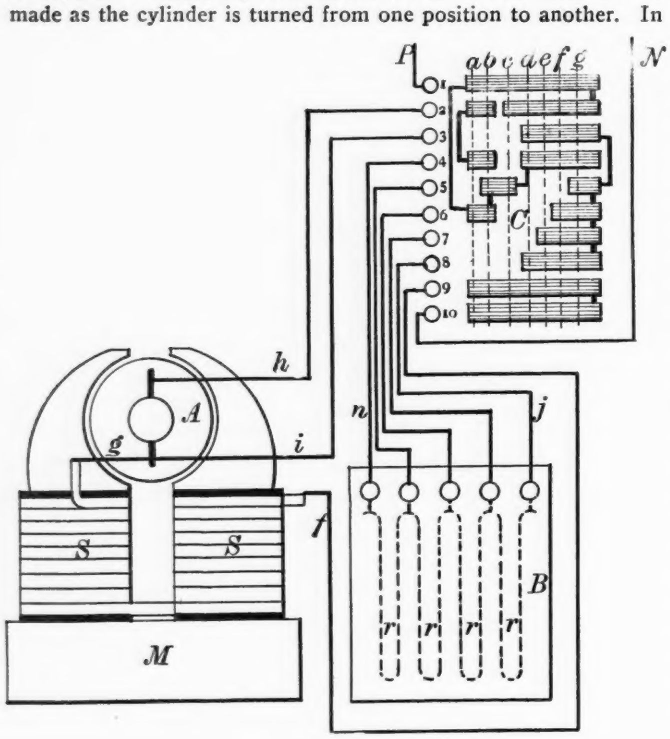


Fig. 5.

Fig. 1, the vertical row of circles numbered from 1 to 8 represents the stationary contacts, while C represents the surface of the cylinder as it would appear if rolled out flat. At B is shown the resistance, or rheostat, which is divided into four sections r r r r, these being connected with the five binding posts at the top. From these posts wires run to the vertical contacts 3 to 7. When the cylinder is turned so that the contacts rest upon it, on the line a, contact 1 will be connected with 2, and contact 7 with 8. With this connection the current from line wire P will pass to the top commutator brush and thence through the armature and the field coils, coming out by wire f. From f the current will flow through wire m to the rheostat B, and after traversing all the sections r r r r will reach wire i and thence, through contacts 7 and 8, the line wire N. When the cylinder is turned far enough for the contacts to rest upon line b, contact 6 will press upon a ring, and then the current will only pass through three of the rheostat sections. When the position c is reached, contact 5 will rest upon a ring, and then only two sections of the rheostat will be traversed by the current. When the position e is reached, all the resistance of B will be cut out.

From the foregoing explanation it will be seen that, by placing the controller cylinder in different positions, more or less of the resistance of B can be placed in the circuit, and, as a consequence, the speed of the motor can be increased or decreased, as desired. This arrangement is what is called a rheostat controller, and it is shown in connection with a series wound motor. A series wound motor is one in which all the current passes through the field coils as well as through the armature. Fig. 3 shows a rheostat controller connected with a shunt wound motor. A shunt wound motor is one in which a very small portion of the current passes through the field coils, and the balance passes through the armature. A simple rheostat controller when used in connection with a shunt motor, has to be supplemented by a motor starter, and the two devices are connected as illustrated in Fig. 4. In this diagram, a is the controller and b the motor starter. The latter is placed in the armature circuit, so that the current passing to the latter must also pass through the resistance of the starter. To start the motor the switches s and ss are closed, and then ss is moved down slowly so as to reach the lowest contact by the time the machine has gotten up to full speed. After that, the velocity is regulated by the movement of switch S, that is, by the movement of the controller cylinder handle. The movement of the controller in this case acts to cut in or out of the field circuit, more or less of the resistance B in Fig. 3. In this way the strength of the current passing through the field coils is varied, and thus the speed of the armature is regulated.

Series motors are sometimes regulated by providing a by-pass or shunt circuit around the armature, so that all, or any portion of the total current may pass through the armature. Fig. 5 shows the appearance of the controller cylinder surface when arranged for this type of control, and Figs. 6 and 7 indicate the connections in the act of starting, and after the motor is under headway. In Fig. 7 it will be seen that the current coming in through line wire p can pass through switch s to e and thence to and through the armature, coming out by way of the lower brush b. It can also pass through the resistance R and through wire d, thus reaching point c without passing through the armature. Now it is evident that if the resistance of R is reduced, the current through it will be increased and that through the armature will be reduced. If we were to attempt to start the motor with this connection, the current passing through the armature would be very great. Therefore, to avoid such an occurrence, the starting connection must be as in Fig. 6 in which, it will be noticed, wire d is disconnected from R, and the latter is in the circuit of the armature, so that all the current coming through wire P must first pass through R and then through the armature. In Fig. 5, when the contacts rest upon line a, the current passes from contact 1 to 6 through the connection shown. From contact 6 the current passes to center post of B and through the two sections r r to the left, and thus to wire n, and contact 4. This contact, as will be seen, is connected with 2. Thus the current after passing through one-half of the resistance of B finds its way to the top commutator brush, through wire h. Leaving the field coils by wire f, the current reaches contact 9 which presses on a ring that is connected with the lowest one, upon which contact

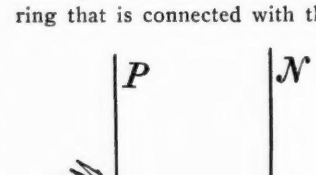


Fig. 6.

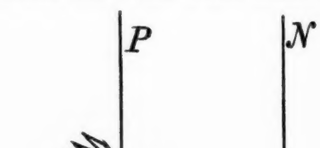


Fig. 7.

10 rests, and to this latter line wire N is connected. When the controller cylinder is moved to position b, only one of the resistances r of B is in the circuit, and when position c is reached all the resistance is cut out. When position d is reached, contact 4 is connected with 1 and then the wire i will be connected with contact 3 and, through the cylinder connections, with contact 8, which, by means of wire j, connects with the right side of B. Thus in this position the circuit connections become as in Fig. 7, and the further advance of the controller cylinder acts to reduce the resistance in the shunt circuit around the armature, and thereby reduce the current through the latter and consequently the force with which it turns.

Fig. 8 illustrates a series commutated field controller. As will

be noticed, the field coils are divided into three sections which may be of the same size or not. If they are made of unequal sizes, a greater range of regulation can be effected, but for the sake of simplicity, we here take them of the same size. Fig. 9 shows the way in which these field coils are connected for the different positions of the controller. In position A all the sections are in series, so that the full strength of the current passes through all the coils. Under these conditions the speed of the motor will be the lowest, and in the act of starting the current

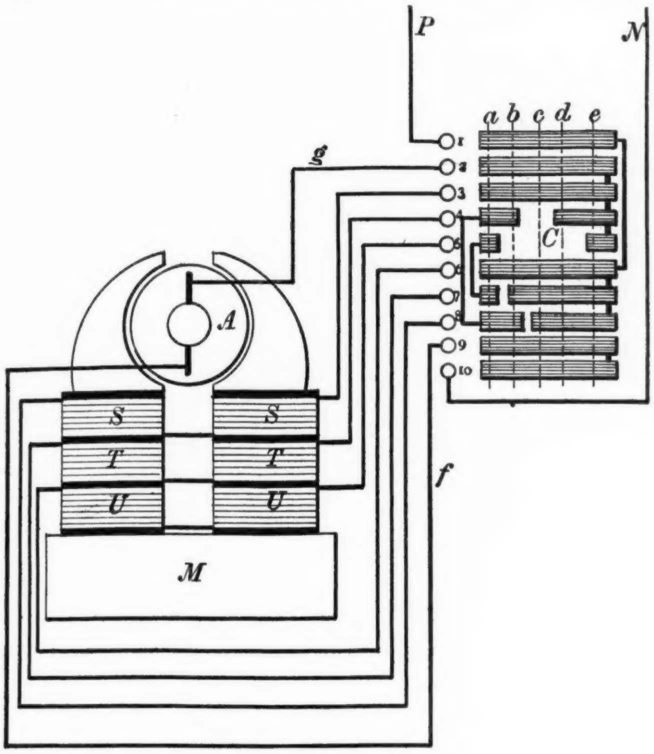


Fig. 8.

that can pass through, the armature will be kept down to reasonable limits. In position B the current passes in series through the s s and t t coils and the other two are entirely cut out. In position C only the s s coils are in service. In these three steps the speed is increased progressively owing to the fact that the field magnets are not magnetized so strongly in each succeeding position. In position D, the s s and t t coils are connected in parallel, so that the current is divided between them, and in position E the three sets of coils are connected in parallel and through each set only

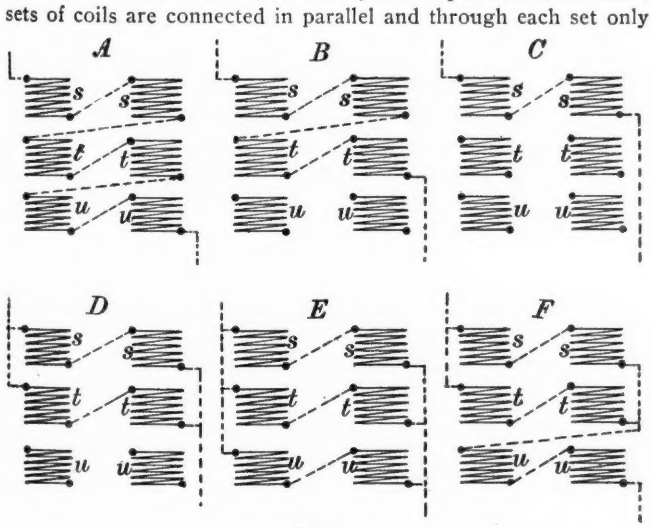


Fig. 9.

one-third of the current passes. A fifth combination is shown at F, but the controller in Fig. 8 is not provided with means for effecting this combination. With this arrangement the armature and field are in series, so that all the current passes through both parts; hence, this type of connections is called the commutated field for series motor. Commutated field controllers for shunt motors are also made, but like the rheostat controller for shunt motors, they have to be supplemented by a motor starter, or a controller so arranged as to perform the office of starter as well as controller. The types of controllers shown in Figs. 1, 3 and 8 are the best, and Fig. 5 is not often used .

All the arrangements shown in the illustrations so far mentioned, can be used in connection with reversing motors as well as with those that are required to run in one direction only. To make any one of these controllers of the reversing type, all we have to do is to add two contacts at the top, as shown in Fig. 10, which illustrates a reversing controller of same type as Fig. 1, and increase the diameter of the cylinder slightly, so as to be

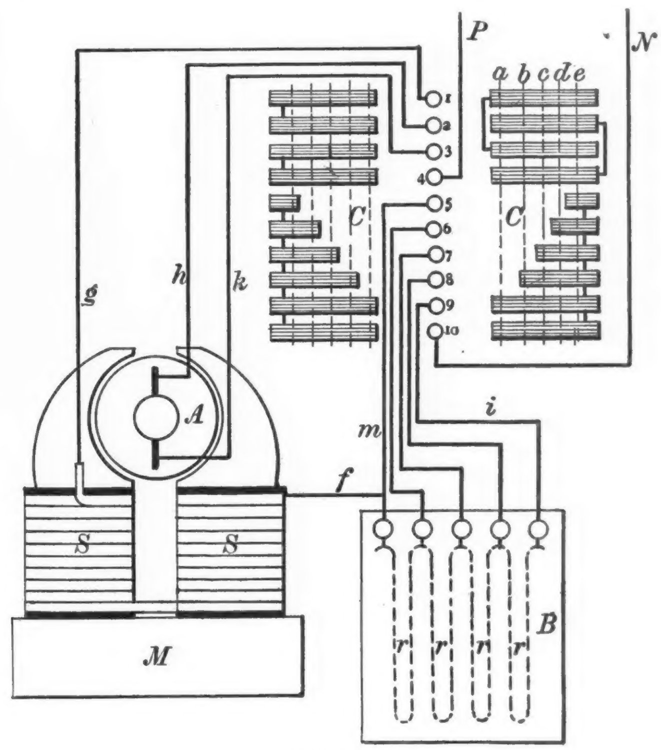


Fig. 10.

able to locate thereon a duplicate set of contacts, as indicated at C C. Looking at the contact rings on both sides, it will be seen that the difference between them is, that in those on the right, rings 1 and 3 are connected as are also 2 and 4, while in the left hand side, ring 1 is connected with 2 and ring 3 with 4. It will also be noticed that contacts 2 and 3 are connected, by wires h and k, with the commutator brushes and that contact 1 connects with the end of the field coils and contact 4 with line wire p. Now to reverse the direction of rotation of a motor all that is necessary is to reverse the direction of the current through the armature, leaving that through the field unchanged, and this is accomplished by reversing the connections. As will be seen when the contacts rest on line a, to the right, the top commutator brush is connected with line wire P, and when the contacts rest in the same position to the left, the top brush is connected with the end of the field coil.

* * *

There is one feature in connection with electric driving for machine shops which may be of more importance than the much-discussed question as to whether it is the most economical method of power distribution. When line shafting is used the arrangement of the shops, tools and shafting must be guided largely by the location of the power. It is a case of adapting the arrangement to the power so that the transmission may be both low in first cost and economical to operate. With electric driving, on the other hand, the power can be adapted to the work and the arrangement of the shops, and tools can be such as will afford the greatest facilities for rapid production without regard to the question of the convenient transmission of the power.

* * *

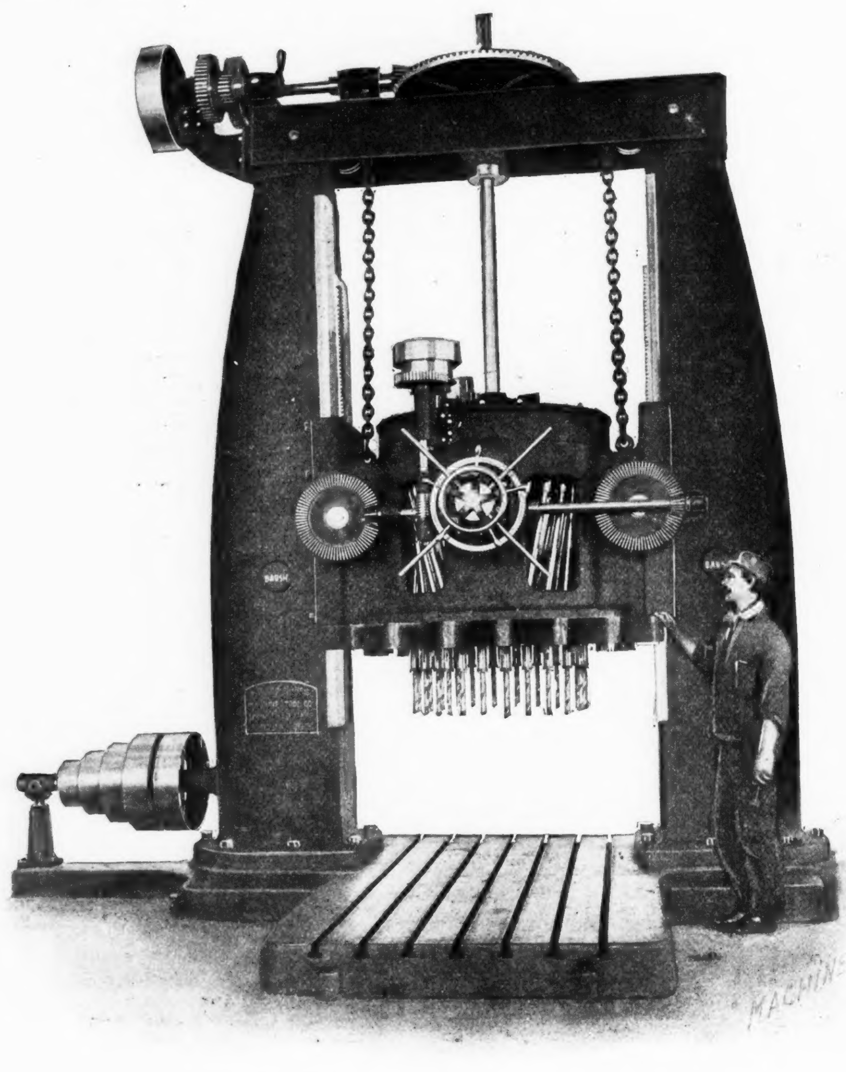
Nations have arisen, cities have been founded and fallen into decay, great battles have been fought, literature and the arts flourished while the steam engine was unknown and the telegraph undreamed of. Surrounded to-day with every luxury, many live contented lives who have never sent a telegram or seen an electric car. COLEMAN SELLERS.

LARGE MULTIPLE-SPINDLE DRILL.

A multiple-spindle drill of unusual proportions has recently been built by the Baush & Harris Machine Tool Co., Springfield, Mass., and is now added to their regular line of manufacture. It is designed especially for drilling the flanges, etc., of large valves, steam and water cylinders and any similar work where a large number of holes can be advantageously drilled at the same time. The machine has 24 drill spindles and has sufficient power to drill 24 1¼-inch holes in cast iron at once. The extreme height of the machine, with the head raised, is 16 feet and the floor space occupied is 14 feet by 6 feet 6 inches. The general proportions can be judged by comparing with the operator, who appears in the illustration with the machine.

The drill spindles, with the driving mechanism, are contained in a massive head which bears upon two uprights or posts and is guided by them. The power and hand feeds and quick-return motion, usually found in single-spindle drills built by the company, are applied to this machine, the only difference being that the feeds are applied to the head instead of to the spindles, so that the latter all feed simultaneously, as is usual in multiple-spindle drills. Each of the posts has a steel rack into which the feed pinions of the head mesh so that the downward pressure when feeding is constant and evenly distributed. While the head is heavy, it is so carefully balanced that it is easily raised or lowered by hand.

The spindles are driven through universal couplings and can be moved radially or circumferentially so as to drill to any circle or to any desired spacing within the limits of 37 inches diameter for the largest circle and 18 inches for the smallest, with 24 drills. Holes can be drilled at center distances as small as 2¾ inches. The general arrangement is the same as that used in the single post machines built by the same company, and which have already been described in these columns.


Multiple-spindle Drill with Twenty-four Spindles.

The general specifications are: extreme distance, spindle to bed, 5 feet 6 inches; least distance, 18 inches; distance between face of posts, 5 feet 1 inch; speeds, 46 to 325 revolutions; feeds, 1/16 to 1½ inches per minute; changes of speeds, 8; feeds, 16.

* * *

Judging from letters that we have received from several firms in Great Britain, the general opinion is that the South African war will not injure the machinery trade in that country, and some state that it is a positive benefit to the industry as a whole and will probably continue to exert an influence in that direction. While there is a falling off in the demand for mining machinery, such as has been shipped to South Africa in considerable quantities, this is more than offset by the demand for war material. The call for machine tools to turn out these products, as well as for regular lines of work, is active. There is a great scarcity of raw material and coal is getting scarce owing to the limited capacity of the collieries. Of the number of men who go to the war, few are of the class who holc positions as mechanics in manufacturing establishments. The number of engineers who are in the government service is very small.

AT THE BILLINGS & SPENCER SHOPS.

A representative of MACHINERY who called at the Billings & Spencer Co.'s, Hartford, Conn., recently found all departments busy and engaged upon a great variety of work, both in the machine and drop forging line. The drop forging department has 60 drop-hammers ranging from the mammoth 3,000-pound hammer previously described in these columns, to the smallest sizes. A significant fact is that a great many motor carriage forgings are now being made, and the variety of other work called for by customers shows the value of drop forgings for practically all lines of metal work.

In the office are samples of many of the pieces that have been made. One of these is a forging for a pistol butt produced by Mr. Billings in 1862. A considerable number of machinists' tools are forged and finished at these works, ranging from a small pin vise to the largest wrenches. The latest of these tools is a neat knurling tool which possesses features that mechanics will appreciate. The shank of the tool is to be placed in the lathe tool post and on its outer end is a swivel holder with two sliding jaws, similar to the jaws of a vise, which can be closed or separated, by a thumb screw. These jaws slide in a vertical plane and each one carries a knurl. It is thus possible to so adjust the holder that one knurl will come below the piece to be knurled and the other diametrically above it. When the knurls are then brought together, the pressure of the upper one upon the work balances the pressure of the lower one and no strain is brought upon the lathe centers. This tool is said to knurl rapidly and to do good work.

In view of the many uses to which drop forgings are put, some of which require the best tool steel, this company have their own chemical laboratory and have adopted the plan of analyzing samples of all steel used so that it will be known to a certainty what the percentage of carbon is in each case.

Among the interesting work done here are the hollow crowns for bicycle forks that have been so much in vogue the past three or four years. These crowns are in the shape of an inverted U and are hollow all the way through. A section through one of the arms of the U would be oval in shape, with a uniform thickness of the metal all the way around. When these were originally made in the form of castings, they were clumsy and heavy, but now that they are forged they make a light, strong and a pretty piece of work. The process is first to forge the metal into a Y-shaped piece with cylindrical arms at right angles to each other. These arms are then drilled from the ends, lengthwise, until the holes meet at the point where the two arms join. They are then heated and put under the drop hammer, when it is found that, by suitably shaped dies, they can be brought into the U-shape and have the oval cross-section as well. At first it was thought necessary to fill the holes that had been drilled with sand, resin or some other material, just as is done in bending pipes, when finishing the piece; but it was found that if the conditions were right this precaution was unnecessary.

Many of the dies used in drop forging are so large that most tool-makers would hesitate before trying to harden them, if they were not accustomed to such work. No secrets are employed in the process, however, and excellent results are obtained by the old-fashioned methods of a proper application of fire and pure water. The dies are heated in furnaces resembling case-hardening furnaces and then withdrawn and their faces held in a tank of running water, the supply bubbling up beneath the die so as to continually change the water in contact with it. Water is also poured over the back of the die in sufficient quantity to keep the surface of the block straight and true, as determined by the frequent application of the straight edge. At the right time the dies are removed from the water and left until the temper has been drawn to the desired color, the temperature at the center of the block generally being high enough to effect this. Hardening these dies requires much skill and experience, but the method itself has no features that most mechanics are not acquainted with.

The machine department of the Billings & Spencer Co., while probably secondary to the drop forging department, is an important adjunct to the business. Besides the die making, which itself requires a large force, many of the forgings are finished complete, machine work and all, before shipping. Drop hammers are also made in a variety of sizes. These have recently been improved in a number of particulars, not the least of which is the substitution of heavier frames for the ones that were formerly used.

* * *

NOTES FROM NOTOWN.

WANTED, A BUSINESS MANAGER—FINDING FAULT VS. SUGGESTING A REMEDY.

I. PODUNK.

I went to see an old friend of mine the other day and found him in kind of a peculiar fix, yet so far as his end of the job went, it wasn't so bad.

"What this place needs," said Jackson, "is a business manager. It's a good shop—new tools, nice class of work and fine people to work for, but it makes me ache to see things going as they are.

"You know we are building a new style sausage stuffer that will do the job up neater than any machine I ever saw; chops the meat (I almost said dog, but that would be giving away trade secrets), stuffs the cases in just even shapes and is a daisy generally. There's a great demand for them right here in Chicago and we ought to be turning out a dozen a week—but we're not.

"The inventor tries to run the business part of the concern and it don't go. I used to think that if the shop end was all right, almost any old thing in the office could keep track of orders and things, but I found I was mistaken. They are both separate trades and I wish I knew 'em both, too.

"Well, to begin with, their inventor wants to invent everything he uses from speed lathes to jib and traveling cranes; consequently we were a year getting in shape. Rigged up his own grinding lathe, or grinder, he calls it—at a time when we ought to have been turning out machines instead of monkeying with home-made rigs like that.

"Worst of it is, the business management of the place is done by the inventor, too, and he's too busy inventing to pay much attention to the other, and the other counts too, I find. Orders don't even get to me straight until I chase 'em up, and if I was one of the balky kind of men things wouldn't go at all."

Jackson was called away here and I did a little investigating myself, only to find Jackson was right. There was every appearance of thrift about the place, time clock—of the wrong kind however—and other fixings, but things simply dragged along because there wasn't any one to do the steering of the machine. I used to kick at the thought of a manager drawing a big salary and apparently doing nothing, but if it wasn't for this same manager the business would go to smash and you and I would be hunting for a job, perhaps. You don't think he earns so much more than you do? He couldn't run your lathe on your work to save his neck? Probably not my friend, but the reason he gets more than you and I do is because there are lots of men who can turn out just as much and as good work as we can (though they've got to be hustlers, I'll allow), but there's mighty few who can fill his place. If you can find a job that you can do better than anyone else, your wages go up. It's just so with a manager, and if you want to see your name on the pay roll up at the head of the list, just try to learn how things ought to be managed. Don't know how to begin, eh? Well, perhaps I can't help you very much, as I'm no spring chicken, and I still wear overalls, but if I wasn't too old to think of such a thing, I'd try something. When the boss orders a change in any work, try and reason out the "whys" of the case and look at the other side as well as your own. Decide for yourself, but don't tell anyone else whether you think it a good move or not and then watch results. Don't wait till afterward and then imagine you decided right, for a manager has to decide beforehand. Just imagine you are running the shop or even one department and plan out how you could save money for the firm by reducing the cost of production without reducing wages. Think out some system of keeping track of work so you can know what it costs. Find out who turns out the most work, which machine pays the best, and a dozen other points a manager ought to know. When you can do this you are getting to the point where you can appreciate what is required of a manager, and perhaps find an opening of this kind yourself. It's worth trying at any rate.

This leads me to remark that, very often, we are apt to find fault with things and people without being able to suggest a remedy. We criticize the design of a new machine in the shop, yet can any of us, or do any of us suggest a better one? Criticism is a good thing, but it is well to have a substitute to offer for the article we condemn.

"Unhandiest lathe I ever saw," says one, but how would you improve it? Of course you can do it—probably—but isn't it better to do it than to growl about it? Begin at the carriage, the part you notice the most, and, while your lathe is in a cut study out how to make things better. Then, when you get time, make a few sketches to show your ideas.

Sketches are good things in several ways. They train a man's fingers, as well as his brain, and they show up the fallacy of an idea, pretty correctly too, if they are well made.

If any mechanic follows this plan whenever he can, he is sure to add to his stock of ideas and to be able to express them on paper. It also makes his opinion of more value, and when he kicks at something he doesn't like, he isn't a mere growler but is recognized as one who has improvements to suggest. In other words, it is the difference between those who tear things apart with no idea of how to improve them or build them up, and those who do not attack existing conditions until they have something to offer in their place. The last man is the chap who will succeed in life.

* * *

At Holyoke, Mass., the "Paper City," a new dam has recently been completed across the Connecticut that is 1,020 feet long, 30 feet high and is the second largest overflow dam in the world, the largest being at Austin, Texas. The new dam is located about 100 feet below the old dam, which made Holyoke famous as the city with the largest developed natural power in the world. Nearly 11,000 pieces of granite were used in the new structure, and 39,000 barrels of cement.

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MARCH, 1900.

CIRCULATION STATEMENT.

The regular edition of MACHINERY for March is 25,000 copies. AMERICAN MACHINERY is the title of the foreign edition, printed on thin paper and comprising all the reading and advertising matter in the domestic edition. No subscriber is entered on our mailing list until his subscription is paid for, and all subscriptions are stopped at expiration. Except on the special quarterly numbers, no papers are sent free other than to advertisers, exchanges and circulation agents.

The circulation of the three leading papers in the machinery trade, so far as it is possible to obtain the figures, is as follows:

THE IRON AGE, about	7,000
THE AMERICAN MACHINIST, about	12,000
MACHINERY	25,000

It so happens that we are able to illustrate this month two multiple-spindle drills, which show in a very striking manner the tendency of modern shop practice when the volume of business is sufficient to warrant their use. One does not have to go back many years to reach the time when multiple-spindle drills or any other type of machine for performing more than one operation at once were scarcely known. Later small machine parts began to be made by such methods, and now, with better facilities for handling large machines, a great deal of the heaviest class of work is done on this principle. One of the machines that we refer to is for small work and is unusual from the large number of spindles that it contains. The other is for a heavy class of work and is more massive than any similar machine that we remember to have seen. The two together illustrate how completely both heavy and light work has come under the sway of what may be termed the modern method of machine manufacture.

* * *

AN OBJECT LESSON.

The employees of a certain New England shop, which is doing a good-sized business, were surprised on pay day, a short time ago, to find that their envelopes contained more money than was due them for the number of hours they had worked during the week preceding. Individual employees called at the office to say that there had been a mistake, while others, who compared notes, found that all had been treated alike and that the surplus received by each was 10 per cent. of the previous wages.

While this is a pleasing (and somewhat unusual) instance, there are several things that may be said in connection with it that are even more unusual than a uniform increase of 10 per cent. in wages. In the first place, the raise was unheralded and as far as we know no attempt was made to advertise the fact, no mention being made of it, even in the local papers. It is an old-fashioned shop with many tools and methods that are not strictly what we would call modern. The shop has paid large enough dividends, however, in spite of these drawbacks, so that the directors were willing to accord a slice of the profits to the men by whose labor the money had in part been earned.

Among the old-fashioned features of this shop, or rather the lack of modern features, is the absence of a checking system for the employees, when they commence and close their day's work. If a man is a few minutes late in the morning no account is taken of it, but if he is habitually late, his services are no longer wanted. The shop is rather dark and not as clean looking as many of the newer structures, and it does not have the shower baths, lunch counter and other conveniences for the health and comfort of the workmen found in many places. Yet, if we are correctly informed, it is a shop where machinists like to work and where they stay as a general thing for long periods.

On the part of these machinists, also, it should be said that they show quite a different disposition from that sometimes manifested. There seems to be no objection to running two machines and in fact one man is successfully running several lathes and drawing good wages for his efforts.

The two facts that this company is doing a profitable business with a somewhat inferior equipment and that the mechanics employed by them are well pleased with the conditions as they find them, in spite of the lack of some of the modern conveniences are at least significant. One cannot help but think, however, that the one fact is but the complement of the other. The most profitable adjunct of a concern is a body of men who are so well pleased with their positions that they are ready to reciprocate by extra efforts when called upon to do so.

While we do not wish to be understood as decrying all that is modern and holding that all which is good is of the past, it cannot be denied that a shop like the one alluded to is a typical, old-fashioned shop in several respects and that in some of these it is ahead of some of the newer organizations concerning which we hear so much. The new shop has much that is for the better that those of the old never dreamed of. It has better light, heat and ventilation. It has lavatories and sanitary arrangements that were unheard of, even a few years ago, and many other conveniences, not to speak of the improved tools and methods for increasing the quantity and quality of the output. All these go to make the modern shop vastly better and more productive than the old-fashioned shop; and yet, it is very evident that these are not all, nor even the chief things desired by a mechanic. Fair and generous treatment, first of all, is what he desires. He wants to feel that he is a man with individuality instead of a machine, and any step taken in this direction will do more to make a machinist a valuable man for a firm to employ than any other one thing. On the other hand, no mechanic can expect such treatment unless he himself is ready to do, perhaps a little more than his share, if need be, toward bringing such a result about. If there could always be the mutual good feeling that we believe exists in the New England shop above referred to, the modern shop, with all its modern attractions, would be an ideal place in which to find employment. Some shops do at least approach such a condition, but many do not. Every one that does, however, is a powerful object lesson, and will help win over those that do not.

* * *

The largest locomotive in the world is stated to be one built recently by the Brooks Locomotive Works for the Illinois Central R. R. It is of the 12-wheel type and weighs 364,900 pounds complete with the tender and 232,200 pounds without the tender. The boiler is 6 feet 8 inches in diameter, the grate area $37\frac{1}{2}$ square feet and the cylinders 23 x 30 inches.

AMONG THE SHOPS.

THE MANUFACTURE OF DIES AND DROP FORGINGS.

Drop-forging is a peculiarly interesting process to both machinists and blacksmiths, but one that is not very well understood by the great mass of either trades. It is a process in which some ingenuity and much experimenting have been required to bring it to its present state, as, not theory, but practical conditions and the peculiarities of the material being worked determine its limitations. It may quite properly be called "machine blacksmithing," as the work of the blacksmith is duplicated mechanically, but in a superior manner and at a rate that leaves no room for hand labor competition, when sufficient quantities of any one article are required to warrant the expense of the dies.

What makes drop-forgings more desirable to the manufacturer than a low first-cost is, however, the close approximation to uniform size that exists in the forgings when they leave the finishing dies and the homogenity of their material. In the manufacture of machines having interchangeable parts which are of a very complicated and irregular shape, the drop-forging plays an important part. The building of machines on the interchangeable plan is one factor that has contributed to bring the drop-forging industry so quickly into favor, as it is comparatively an "infant" industry. Something less than fifty years ago, Col. Colt adopted in a limited way the use of drop-hammers in the manufacture of the small parts to his famous firearms. The events that followed, culminating in the Rebellion, greatly stimulated the manufacture of firearms and, consequently, that of drop-forgings, but the principal development of the industry has been within the last quarter of the century.

Being considerably interested in "machine blacksmithing" and thinking that many readers of this journal might appreciate some information on the subject, the writer recently visited the plant of J. H. Williams & Co., at Brooklyn, N. Y., and there received not only many new ideas regarding the manufacture of drop-forgings, but some very refreshing ones on shop system and the management of employees.

The means employed for forming the hot and plastic metal into the desired shapes make drop-forging a somewhat hazardous occupation. A genuine desire on the part of the management to avoid distressing accidents has led to extraordinary precautions being taken to avoid them. The erection of safeguards for accident prevention is not, however, confined to the drop-forgings departments, but, as will be seen from a look at the double-page engraving, they are placed throughout the shops and in many places where the danger of accident is comparatively slight. This safeguarding of the employees' persons is not by any means confined to merely preventing mechanical injury, but the general effort is to promote their general health and welfare in many ways that will be apparent further on.

Making the Dies.

The first step in the manufacture of drop-forgings is, of course, the making of the dies. A model of the part to be forged is usually whittled out of wood, if it be of a form not clearly shown by a drawing. Given this model, a scale drawing and the required weight of the finished forging and the die-sinker has the principal data required by him for making the dies. To this information should be added, however, the number of forgings required and the allowable limit of variation from the stated dimensions. If only a few hundred forgings are to be struck from the dies, they may just as well be made from a low grade of steel and need not be fully hardened. If, however, thousands of forgings be required, the dies must be made of the best steel and most carefully hardened to stand the test of protracted hammering. It is evident that the dies made for many forgings are more expensive in the first cost, but the cost per forging is usually far below that borne by the dies made for the smaller number.

The die-sinker determines, from his model, the best "parting line" for the forging in much the same way as does the patternmaker on the pattern for a casting, but the analogy between the two is comparatively slight as the conditions are radically different. The patternmaker can use cores and loose parts to make cavities and overhanging parts, but the die-sinker is practically limited to a die opening in two parts, which must be made to stand the roughest usage. When these conditions are considered, it is surprising to see the apparently impossible forms that are successfully drop-forged.

The outline of the piece to be forged is drawn on the surface of the die which has been coppered with a blue vitriol solution, thus causing the lines to stand out sharply. The metal is then removed in the manner that is most expedient for that particular example. If the outline be circular and of a shape similar to a cylinder-head, the most obvious way is, of course, to bore out the stock on a lathe. It should be stated that the die blanks are planed in pairs before die-sinking is started and the dove-tails for fastening the dies in the hammer are all finished.

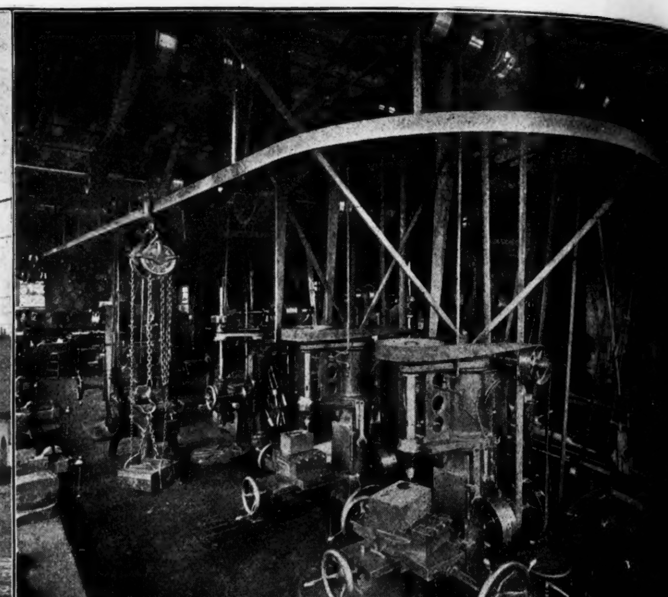
If the shape of the forging be such that other means are required for removing the metal from the die, the profiling machine readily furnishes a means for following the most complicated forms and cutting away the stock by means of milling cutters of various shapes and sizes. In case the piece to be forged be of a comparatively long and regular section, either the shaper or milling machine may be used, after the ends are worked out, as may be found most expedient. Drilling and chipping are commonly-used means for die-sinking, and, in almost any case, a liberal use of the file, riffle and scraper is required to finish the die to the required smoothness and regularity.

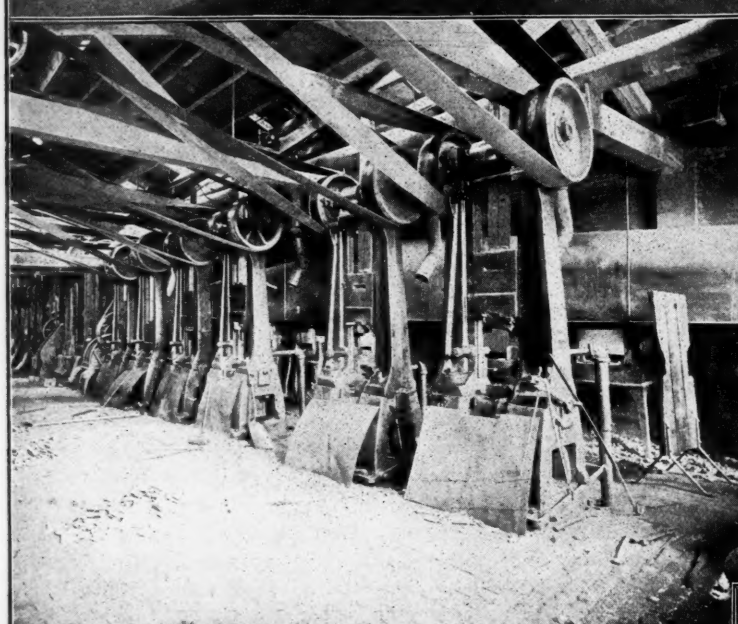
The forming of an irregular cavity in the face of a high-carbon steel die so that, when its mating die is matched to it, the shape of the inclosed space shall not vary from the specified dimensions more than two one-thousandths of an inch either way, is an operation of the highest order and one necessarily requiring time, patience and skill. After the die-sinker has formed the die to the desired shape, a "proof" is taken by filling the cavity with melted lead. If the forgings are to be made for a customer to his order, the proof is submitted to him before hardening the die. If any minor changes be needed, they are made and a shallow space cut in the face of each die around the cavities. This is for what is technically called the "flash of the die." As it is practically impossible for the drop-forge operator to form the billet of iron or steel into just the shape and size required for the forging, this space must be left for the overflow of surplus metal.

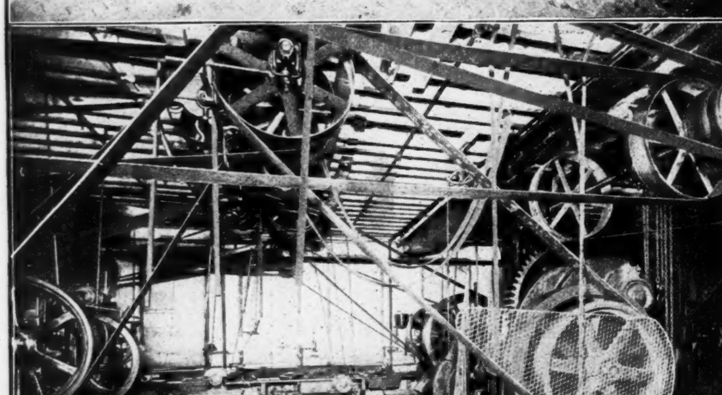
The overflow of metal or "flash" has to be trimmed off, after the forging operation has been completed, in trimming dies which are made in another department, as shown in the double-page cut. The trimming dies are made in male and female form, the upper part being the male die and the lower die the female. The male die is made of the outline of the forging through the parting line and with its face conforming to all the irregularities of the upper part of the forging to be trimmed. This is especially necessary on light forgings to prevent distortion of the pieces during the trimming operation. The female die is open at the bottom so that the trimmed forging can fall through it into a receptacle under the press. It is also made with its cutting edge conforming to parting line or flash of the forging for the same reason given for the shape of the male die. A female trimming die is plainly shown in the engraving at the left of the die storage cellar, leaning against the die racks. On the right, two pairs of dies for forging wrenches are visible.

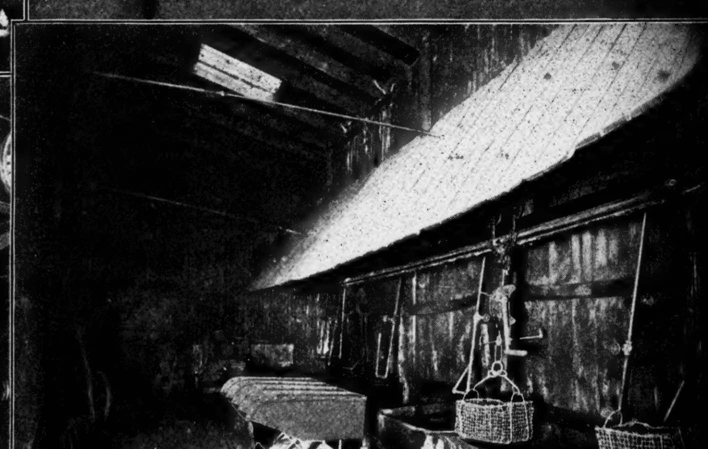
It will be noted from the views given of the die-making rooms, that the shaper and profiling machines are the principal machine tools used. An overhead trolley track, which shows in the die-sinking department, is found to be a very convenient means for transporting the heavy dies from the machines to the work benches on the sides of the room.

The dies are hardened, after the proof is accepted, in the hardening, case-hardening, annealing and tempering department which has furnaces in which the temperature is regulated by pyrometers. The tempering furnaces are furnished with permanent instruments, one of which shows in the form of a steam gage in the cut, but, for the other furnaces that require a much fiercer heat, a portable instrument is provided. The attendant thrusts the stem of the pyrometer through a hole in the furnace front and quickly ascertains the temperature of the furnace. It does









View of shops from the street showing the vines growing over the walls.

Auxiliary forge shop. The air pipes for cooling the men can be seen behind the hammers.

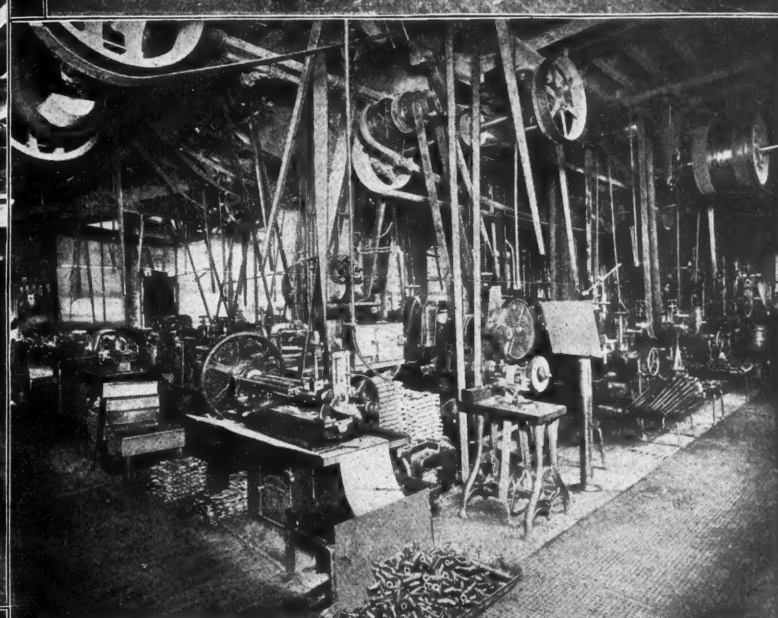
Trimming department. Press shown in the foreground with wire screen over the flywheel.

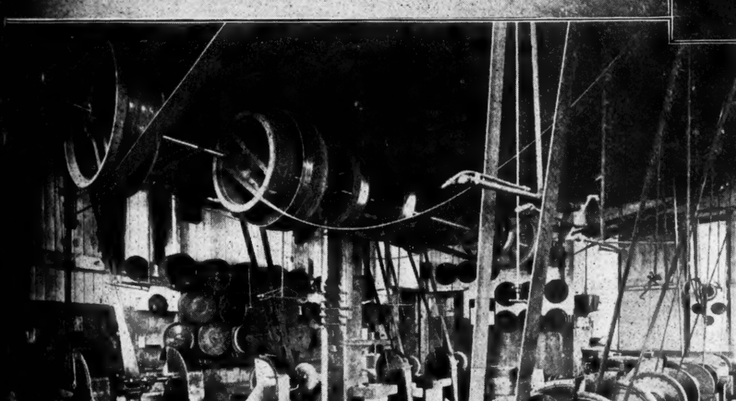
Die-sinking room. Profiling machines for die-sinking and trolley track for handling the dies.

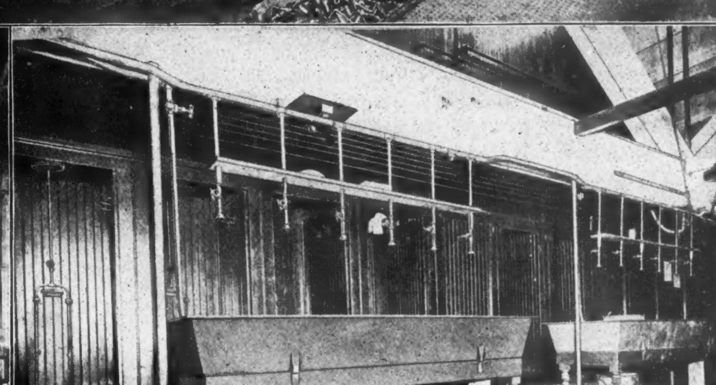
View of the main forge shop from behind the hammers. Air pipes for cooling the men and for blowing the scale from the dies.

Pickling room for removing scale from the finished forgings.

THE MANUFACTURE OF DROP FORGINGS AT T







Trimming die room. The pipes overhead are the exhaust conduits from the polishing room above.

The die storage cellar. Nearly 8,000 sets of dies are stored in this room.

Polishing room with an exhaust head for each wheel.

Hardening, case-hardening, tempering and annealing department. Pyrometers used here for gaging the heat.

Finishing room with a broaching machine in the foreground.

View of the bath-room showing the shower baths and tubs for washing clothing.

RGINGS AT THE WORKS OF J. H. WILLIAMS & CO.

not require a great deal of acumen to perceive that such a method for determining the temperature of a furnace, in which high carbon steel is being heated, is far better than the usual guesswork plan. The permanent qualities of the dies hardened and tempered under these conditions fully pay for any additional expense incurred, with a handsome profit in addition.

Drop Forging.

Having briefly followed the die from its rough state to a finished condition, we are ready to enter the drop-forging department and see them in actual operation. About fifty drop-hammers are in use in this plant, ranging from those having rams weighing 2000 pounds down to those weighing only 200 pounds, but the average weight of the rams most used is about 800 pounds. In the drop-forging rooms, of which there are two, we see forgings turned out that range in weight from 100 pounds to 1-16 of an ounce and covering the whole range of industrial art. We noted shoe-horns and cream separators, surgical instruments and parts of rapid-fire guns, pieces made in iron, steel aluminum, copper and tobin-bronze for manicure sets, deep well pumps, pencil erasers, projectile tips, golf irons, etc.

The auxiliary forge shop is in a building across the street from the main building shown in the engraving and in it are made the lighter and cheaper forgings. The main forge room, shown in the second view, contains the heavier hammers. The view shown is taken from a photograph of the alley between a row of drop-hammers and the furnaces in which the metal is heated. A pipe is shown sticking up through the floor at each hammer with a nozzle directed towards the dies. A current of compressed air passes from the nozzle against the piece being forged and blows away the scale as fast as formed. The operator raises the metal from the lower die after every drop of the hammer, so that the scale on the under side may be swept away and thus prevent pitting and roughing the forging. Of more importance from a humanitarian view, however, is the pipe, with the short sections extending downwards, that can be seen overhead. This is a pipe supplied by a blower and discharging a current of cooling air on the men as they work at the hammers. The conditions that usually prevail in a forge shop during hot weather are very trying and it is often necessary to shut down during the hottest weather as the men are unable to stand the labor and heat. With the arrangement shown, a cooling blast is directed as the workman may desire, the short section being connected to the horizontal pipe by a universal joint so that it can be swung to any desired position. The writer was informed that during the hottest summer weather of 1899, it was not necessary to shut down, an occurrence before unknown. The temperature behind the hammers was from 10 to 20 degrees less than in any other part of the plant, so that the forge men had about the coolest place to work in.

The drop-hammers are of the board type, that is, the head is attached to a maple board which is gripped between friction rollers and raised by them until a predetermined height has been reached when it is released by a trip. Strange as it may seem, these boards have an unaccountable way of breaking short off and sending splinters and fragments flying in a dangerous fashion. To prevent accidents from this cause, each drop-forge man is protected by an overhead screen to catch any broken pieces in case the board breaks on his machine.

In some instances the forgings are required to have a very smooth finish as they leave the dies. In such cases, water is sprayed on the forging just before being completed, which dislodges the thick scale or oxide formed and leaves the piece with a thinly oxidized surface that requires very little work to form a highly finished surface.

Pickling the Forgings.

The scale on the greater part of the drop-forgings is removed, however, by being immersed in a pickling bath of water and sulphuric acid. The pieces are thrown in the metal baskets shown and lowered into the vats until the scaling process is completed. One of the workmen has rigged up the labor-saving device shown for raising the baskets from the pickling vats. This is mentioned to illustrate the efforts made to encourage the men to originate ideas for facilitating any operation. Suggestions are listened to, and, if found of value, are adopted. The truck for transporting the forgings to and from the pickling room is a convenient affair. Four trays or buckets are pivoted on the truck so that, when filled with pieces, the center of gravity will be behind the pivot or opposite the spout end. A sheet of wrought iron is pivoted to the top of the truck and turned up to support the spouts of the buckets and is hooked in this position when transporting forgings. When a department is reached where the forgings in one bucket are wanted, the sheet iron piece is unhooked and turned down. The bucket can be easily turned to discharge its contents without disturbing the contents of the others. In this way all of the buckets are unloaded where wanted without the necessity of handling individual pieces.

The Trimming and Finishing Departments.

After the forging has been pickled, it is necessary to trim off the fin or flash of the dies. In some cases, however, the forging is hot trimmed, immediately after being formed. If it is to be hot trimmed, the press and trimming-die are located in the drop-forging room alongside of the hammer and the trimming is effected after the forging operation is completed. but while the piece is still hot. When the trimming is to be done cold, the forgings are taken to the cold trimming department shown in the engraving. An elaborate guarding for a press flywheel may be seen in the foreground. The trimming operation may complete the forging ready for shipment, or it may need to go through other operations as may be specified by the customer. Quite an extensive line of machine work on forgings is done to order, but the greater part done is on regularly manufactured tools which are finished ready for the trade.

In the finishing room considerable broaching is done on pieces like bicycle cranks. The machine shown in the foreground operates by pulling the broach through the part to be broached. A stream of oil is directed on the piece as the broach is pulled through. The broach is held in a carriage mounted on two circular guides at the sides and connected to a long screw on which is engaged the large internally threaded gear. The operator has to release the broach from the head for each piece to be broached and thrust the shank of the tool through the drop-forged hole. The smoothness and accuracy of the work are such that nothing more is required to be done to the hole when a piece is fitted into it. Holes are also broached tapering when required.

The Polishing Room.

In the view of the polishing room, we see that each emery wheel and polishing head is provided with an exhaust head for removing the particles of dust and metal from the air as fast as formed. So effectually is this done by the exhausting system, that the room is as endurable as any other in the works. There is a total absence of dust and lint, which when flying through the air are so injurious to health and which make the average polishing room a breeding place of disease. The elaborate system of piping necessary for the polishing room shows overhead in the trimming die room. The heavier particles are discharged in a settling chamber by centrifugal action, while the lighter and volatile products escape with the exhausted air on the roof.

Die Storage, Fire Protection, Etc.

The dies are stored in the basement and here we find nearly 8000 sets of forging and trimming dies, of which over 5000 are in active use. The system for keeping track of the dies is quite simple. The racks are numbered, as will be seen in the engraving, and the shelves are lettered. Along the face of the shelves are stenciled the numbers of the dies which correspond to the number stamped on the dies themselves. A type-written list is posted which shows at a glance in what rack and on what shelf any number of die may be found, so that among the thousands of dies stored, any die can be produced without delay after the number is given to the man in charge.

To protect the building and its contents from fire, a most elaborate system has been worked out, in which certain men in each department have certain specified duties. A fire pump is located in the engine room and is always under steam, so that it can be started instantly. It is the duty of one person in each department to send in an alarm to the city fire department in case of fire in his vicinity, and others have the charge of the hose and know what their duties will be in case of such an emergency. The sprinkling system is also installed, as will be seen by the overhead pipes in the die cellar, and. although the plant is not strictly fireproof, the danger from a disastrous fire must be very slight. That this is an important consideration, to a customer

who has drop forgings made to fulfill certain contracts, goes without saying. Oftentimes the failure to obtain certain small parts of machines for filling large contracts causes a loss many times the actual value of the parts themselves.

For the comfort and convenience of the employees, the extensive bath rooms shown are provided which are appreciated by them, especially in the heated term. Tubs are also provided for washing the outer garments of the men, so that if desired they can always have clean outer clothing. Among other helps to the workmen, we may add that a mutual aid association is in active operation for the relief of distress in case of sickness or accident. An insurance on workmen's tools to protect them from loss in case of fire or theft is another of the minor schemes that appeal to the philanthropically inclined.

* * *

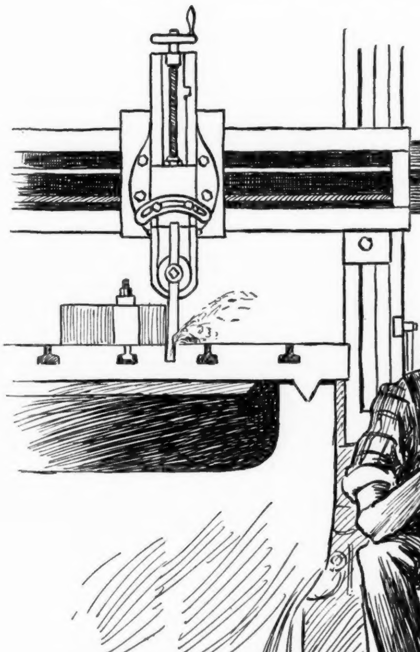
The following historical facts about the growth of marine engineering in the early years of the present century are reported by "The American Shipbuilder" to have been given by Charles H. Haswell, the well known engineer. John Stevens, of Hoboken, N. J., in 1809, applied slides and a crosshead to guide the piston rod of a steam engine. In 1824 James P. Allaire introduced the Woolf engine, the compound of the present day. The first introduction of steamboat towing was made in 1825 by a New York company. In 1826 a fan blower was introduced by Robert L. Stevens. In 1837 the first steam launch was designed and directed by Charles H. Haswell, Chief Engineer U. S. Navy. In 1839 Francis B. Stevens invented and patented the double eccentric cut-off; the same year Edwin A. Stevens designed and operated a closed fire-room. In 1846 Captain John Ericsson designed and applied a surface condenser to the engine of a United States revenue cutter. In 1848 Mr. Pierson improved upon it, and soon after Chief Engineer William Sewell, U. S. Navy, further improved the construction, and in the same year Frederick E. Sickles devised the application of steam to the steering gear of a steamer.

* * *

A common sewing needle held in a suitable handle makes an excellent scriber for accurate work. It is so cheap that grinding is unnecessary, as, when dull, it can be simply replaced by a new one. The point on a needle is ground by an expert and is far superior to anything possible by the ordinary machinist.

* * *

SHOP TERMS ILLUSTRATED.



STEADY REST.

GAS ENGINE DESIGN.—4.

CYLINDER HEADS AND VALVE ARRANGEMENT.

E. W. Roberts.

There are so many different methods of arranging the valves of a gas engine that it would be unpractical to show one design which would embody in itself the entire range of general practice in this respect. If the reader will take the trouble to inspect the catalogues of a few of the two hundred or more gas engine builders in the United States alone, he will find among them engines in which both the inlet and the exhaust valves are placed in the cylinder head. In others he will see that one valve is in the cylinder head, while the other is in a special casting or box bolted to the side of the cylinder or cast in one piece therewith. In still another class both valves are in special compartments by themselves on the side of the cylinder, while quite often the same compartment answers for both valves. Again the valve-boxes will be found not only on the sides, but on the top and on the bottom of the cylinder, while occasionally the stem of the valve makes an angle of 45° with a plane passing through the center of the crankshaft. In view of the wide range of the practice in this respect, the writer will show two or three examples of valve arrangement and point out what appears to him to be the features that require the most attention.

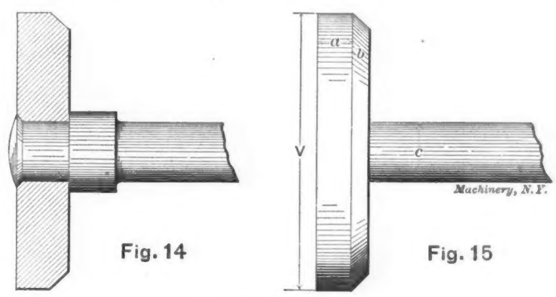


Fig. 14 Fig. 15

Gas Engine Valves.

There are, in the design of all valves and their accompanying mechanisms, several points of importance that should be kept in mind at all times. Quick opening and closing of the valve is desirable in order to prevent useless work being done by the piston, either by drawing the gases in or by driving them out through unnecessarily contracted openings. This rapidity of action is limited in practice by the nature of the valve-operating devices, for, if too rapid a motion be attempted, the cam will, when opening the valve, strike the roller such a blow as to make a disagreeable noise, and when the valve is closing, the action of the valve spring may not be rapid enough to permit the roller to follow the cam. Thus a blow will be struck by the roller as soon as it catches up with the cam. It is usually desirable to sacrifice a little of the power of the engine in order to reduce the noise of the valve mechanism. The exhaust valve, being surrounded as it is at each working stroke with the hot products of combustion, is liable to excessive wear unless means is provided for keeping it cool. Hence it should be the invariable rule to jacket the valve seat by so arranging the water jacket that it will surround the valve opening. It is not neccessary to jacket the inlet valve, as this valve is surrounded at every suction stroke with the comparatively cool, fresh mixture.

With but few exceptions, all gas-engine valves are of the mushroom type shown in Fig. 14. The inlet valve may be made entirely of wrought iron or steel, but experience has shown that it is necessary to make the head of the exhaust valve of cast iron, as this material will best withstand the abrading action of the hot gases. The valve stems are usually made of good mild steel. In the case of these valves having cast iron heads, the head is bored to fit the stem and the latter is riveted in place, as shown in Fig. 15. Should the inlet valve be operated by the suction of the engine piston, it should be as light as practicable and the construction of the valve in one piece permits it to be lighter than when of the built up type. It is also desirable in such a valve to avoid a long stem or any other feature that will add unnecessary weight. Regarding the advisability of using an induction valve operated by the suction of the piston, there is much discussion, particularly as to its practicability on large engines. There is no question that it produces a slight wire-drawing on the suction stroke, for the

reason that there must be a partial vacuum in the engine cylinder before the valve will open. Of course, there is always a small amount of power required to open the valve by means of cams, levers and similar mechanism, and this operating mechanism is an additional expense in the manufacture of the engine. As to the advisability of using such a valve, the writer will permit the reader to judge for himself, and merely remark that, while the valve has been abandoned by some, it is nevertheless in use on several successful engines. The mechanically operated induction valve is, I believe, the one in most general use on large engines.

The proportions of the gas engine valve and its stem, as shown by Fig. 15, are as follows. Taking the diameter of the outside of the valve as a unit and calling this diameter v, the remaining proportions are:

$$a = 1/8\ v \qquad (15)$$
$$b = 1/16\ v \qquad (16)$$
$$c = 1/5\ v \qquad (17)$$

Since the angle of the valve seat is 45°, it follows that the diameter d of the valve opening is 1/16 less for each side or 7/8 that of v.

$$\text{Hence } d = 7/8\ v \text{ and}$$
$$v = 1\text{-}1/7\ d \qquad (18)$$

It should be noted that these proportions are intended as a guide merely, and that the designer is expected to use his judgment, to a certain extent, in their use, employing sizes that are nearest to those given and also considering c, when properly guided, as a column under the conditions imposed by the mechanism. The maximum pressure at the opening of the exhaust valve is seldom in excess of 100 pounds per square inch, while the usual pressure at this point of the cycle is in the neighborhood of 40 pounds. The proportion of c given above is suited to long stems, such as are used in engines wherein the stem reaches to a point near the crank-shaft. For short stems this dimension may be proportionately reduced. In the case of light inlet valves operated by suction, the dimensions may be made equal to or even less than b, especially when these valves are made entirely of wrought iron or steel. It is also to be noted that the diameter of the stem could be lessened in this case as the stem is under only a light tension. In small engines this diameter could be safely made as small as 1/6 v and in large engines about 1/7 v.

The stroke of the valve was given in article 3 as 1/4 the diameter of the valve opening, for an area equal to the area of the passage. In a series of engines recently examined by the writer, the valves had, in a majority of the engines, a lift much less than this, with a result that was plainly shown on the indicator diagram in wire-drawing of the charge. It would perhaps be best to exceed this proportion a small amount, say 1-16 inch or so, in order to allow for any lost motion which may occur in the operating mechanism.

A form of cylinder head, usually employed when the valves are placed on the side of the cylinder, is shown in Fig. 16. The head is designed for a ten-inch cylinder with a 1¼ inch counter bore. It will be observed that the head is water-jacketed, and that the thickness of the metal in the head bears the same relation to cylinder diameter as the walls of the cylinder and the water-jacket when calculated by the formulas in article 3. Thus the thickness of the inner wall is in round numbers ⅞". The thickness given by Formula 11 being $10 \times .09 = .9$ inch and since ⅞ inch is .875 inch, it has been chosen. In the same manner the depth of the water-jacket is found by Formula 12, to be 1 inch and the thickness of the outer wall being ½ the inner wall, it will be 7-16 inch. Calculating the necessary size of the cylinder head studs on the basis of 400 pounds per square inch maximum pressure, it is found that six one-inch studs are required. The six studs on a 12⅝-inch stud circle give a distance between centers of 6⅜" or ⅜" over the six-inch limit. This scarcely induces a sufficient departure from the rule to make the use of eight studs imperative. It will also be seen that the stud circle is a little within the center line of the water-jacket. This is necessary in order that the nuts may have sufficient bearing on the cylinder-head. It will be found a convenience, in a cylinder-head of this design, to drill or core a small hole through the head, as shown, and to drill and tap the head on the outside for the indicator connection.

It is best at all events to add a small column of iron in the center between the two walls of the head, even should it not be desired to drill it for the indicator, as the column will serve to stiffen the head without materially adding to its weight. The head shown is intended for a horizontal engine. In case it should be employed for a vertical engine, a hole should be drilled and tapped for the water outlet pipe as shown in Fig. 17.

To return to the subject of valves, a cylinder head designed for containing both the inlet and the exhaust valve is shown

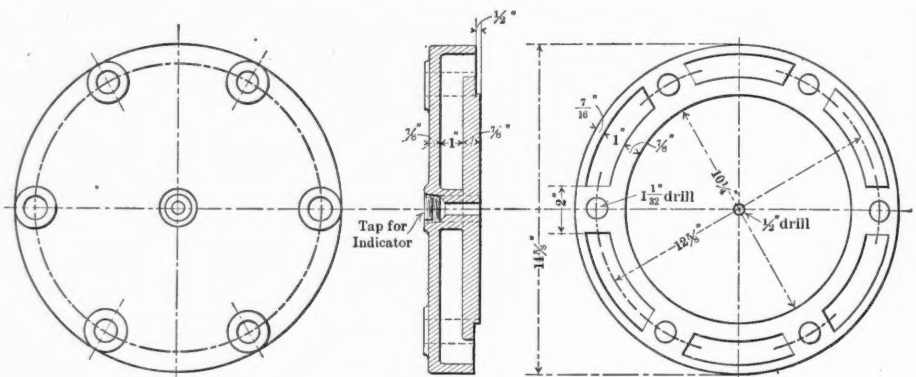


Fig. 16

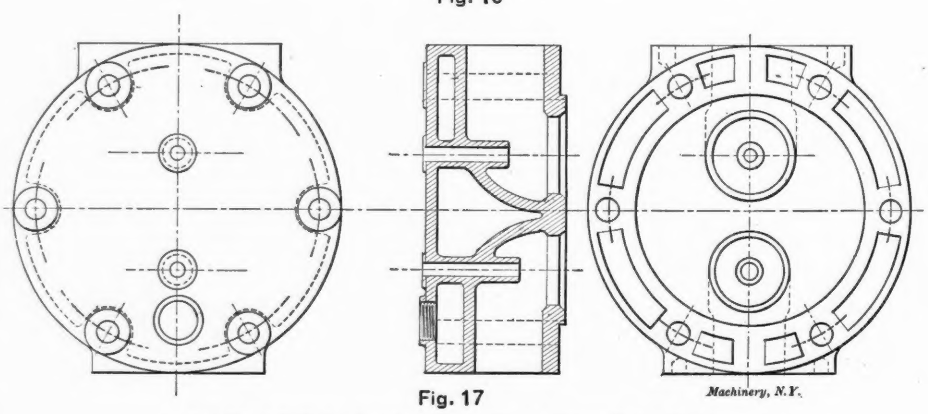


Fig. 17

Details of Cylinder Heads, either with or without Valve Seats.

in Fig. 17. This is an arrangement quite frequently employed on vertical engines. This head is also designed for a ten-inch cylinder and the principal dimensions are the same as in Fig. 16. A close study of this figure will show that the valve openings are nearly surrounded by the water space. While it is not necessary to jacket the inlet valve, the core has been continued around the latter in order to save iron and also to retain uniformity in the design. In the cylinder shown, there is no provision for removing the valves other than to take off the cylinder head. Quite frequently the valves are placed in a separate casting and this casting is bolted in place. It is, however, a difficult matter to arrange these boxes so that, in the case of the exhaust valve, the valve may be properly jacketed and at the same time perfectly tight in every way. This the writer knows, from experience with an engine of this class. The small amount of room at the disposal of the designer will, in all likelihood, compel him to reduce the sizes of the port openings below the size best for good effect, and make the head an expensive one to cast as well as to machine.

In the accompanying figure the dimensions have been pur-

posely omitted for the sake of clearness. Those dimensions not given on Fig. 16 are as follows:

Exhaust valve, 3½ inches.
Inlet valve, 3 inches.
Wall between passages and water space, ½ inch.
Exhaust valve stem, 11/16 inch.
Inlet valve stem, ⅝ inch.
Tap holes for exhaust pipe flange (cap screws), ¾ inch tap.
Tap holes for inlet pipe flange (cap screws), ⅝ inch tap.

The head is also tapped, as shown, for the water outlet pipe. The air inlet pipe is sometimes screwed directly into the opening in the head or valve-box. It would hardly be advisable to do so in the present case, as it would cause much extra work when taking down the head. For the same reason it would be best to use cap-screws instead of studs for bolting on the pipe flanges.

It is occasionally the practice, in the design of horizontal engines, to build the cylinder head so that it contains a part, if not all, of the compression space, to place the pipes at the end of the cylinder, and to put the valve stems through the sides of the head. While this arrangement gives a neat appearing design it would probably be a greater convenience to the repair man to make the cylinder head as light as practicable. Unfortunately the repair man is in many instances entirely overlooked by the designer, and the owner of the engine has an unnecessary amount of expense every time the engine is in need of repair.

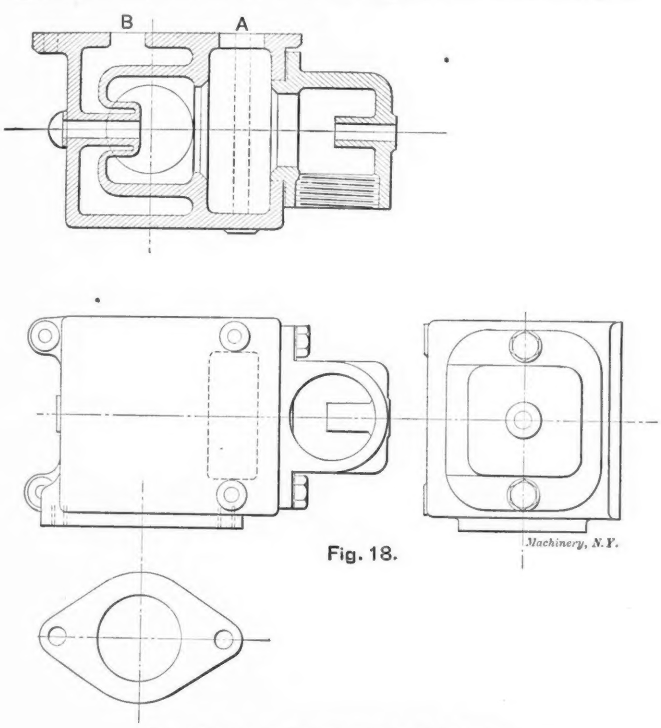


Fig. 18.

Valve Box to be Bolted to Side of Cylinder.

In Fig. 18 is shown a form of valve-box suitable for bolting to the side of the cylinder and designed to contain both the exhaust and the inlet valves in a minimum space. This design is on a slightly larger scale than Figs. 16 and 17 and is for a ten-inch cylinder. The dimensions are omitted as in Fig. 17. The drawing will, however, show the proportions. In this valve-box only the exhaust valve is water-jacketed. The jacket is in this case extended so as to surround the valve stem as far as possible. This is a very good plan and one that appears to find more favor in England than in this country. The exhaust pipe is fastened to the valve-box by means of a flange, while the inlet pipe is screwed to the box. It will be seen that the inlet valve is placed in a separate casting bolted to the end of the valve-box. This arrangement is necessary in order that the valves may be removed and that the valve seats may be machined. The exhaust valve may be easily taken out through the opening for the inlet valve case. The joint between the two castings should be packed with asbestos packing. If a union be placed in the first joint of the inlet pipe, it will be found a great convenience when taking the box apart in case it is, at any time, necessary to grind the valves. Proper openings should be cored in the cylinder for connecting the interior with the opening A and the opening B to the water-jacket. It may be found necessary to connect the water outlet from the cylinder to the top of the valve-box by means of a separate pipe in case the circulation is poor in the exhaust valve jacket. This will not be likely to occur unless a closed circulating system is employed. The designer should provide bearings for the valve stems having a length from three to five times the diameter of the stem, in order to prevent leaks through these bearings. Wear is especially to be guarded against about the exhaust valve stem.

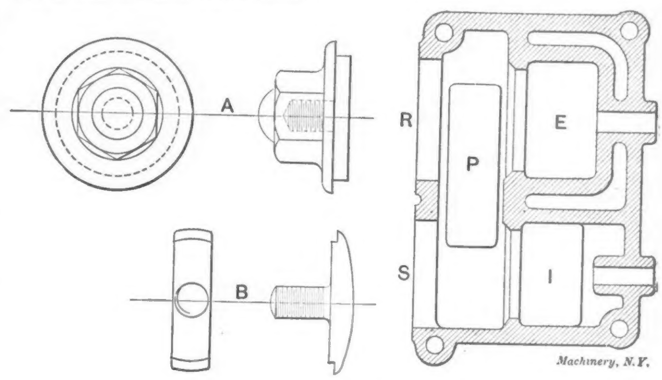


Fig. 19.

Section of Valve Box.

Fig. 19 is a cross section of a valve box in which both valves are placed with their stems parallel and pointing in the same direction. In this case the inlet and the exhaust pipes are attached to the cylinder, the gases passing into and from the cylinder through openings cored in the cylinder. The mixture enters through the opening I, passes through the valve opening shown and thence downward into the cylinder through the port P. The exhaust passes out through P and by way of the exhaust valve opening to the exhaust port E. In order that the valve seats may be machined and the exhaust valves removed, it is necessary to provide the openings R and S. These openings are closed by means of the cap A and the clamp B, the cap A having a ground joint which is fitted to a similar joint on the valve box. It should be noted that, in this case, there are four openings in the base of the box. These are the openings P, E, I and an opening, not shown, from the water space surrounding the exhaust valve to the water-jacket of the cylinder. This valve box is especially adapted for engines in which both valves are mechanically operated from a cam-shaft near the crank-shaft. Valve boxes of this type are employed on both horizontal and vertical engines. When making the valves, a screw slot is quite frequently milled in the valve head in order that the valves may be reground by using an ordinary carpenter's bit brace and a screw-driver bit. The design shown in Fig. 17 is best adapted for engines in which the inlet valve is operated by the suction of the piston.

It is well for the designer to keep the following points in mind at all times. Always jacket the exhaust valve. Remember that the valves must be removed occasionally, and that the design should be such that they may be taken out without tearing the entire engine to pieces. Don't cramp the passages, but keep them always of the same area, and make this area at least as large as that given by the formulas, wherever possible. Make the valve stem bearings of a generous length even if they do look "awkward."

* * *

It has been suggested that the ideal fly-wheel would be one that was arranged to give up or absorb energy more rapidly than is ordinarily done, because of the increase or decrease of the speed of the engine. One solution to the problem, which is interesting, even if not practical, is to have the wheel made with heavy masses of metal arranged to slide on the arms. Normally these masses of metal would be constrained toward the center by means of springs, but when the speed of the fly-wheel increased they would fly outwards and thus absorb energy, because of their increased velocity at the greater distance from the center. When the speed of the fly-wheel decreased these masses would come towards the center and so give up their energy.

* * *

The official opening of the Paris Exposition will take place on Saturday, April 14th, 1900.

LETTERS UPON PRACTICAL SUBJECTS.

AN INGENIOUS SCHEME—READING ADVERTISEMENTS ETC.

Editor MACHINERY:

We had about 10,000 drop forged keys that were about .010" or .012" too wide. It looked as if it would be a big job to file all these keys to size, but we did not have to file them. I took a piece of wrought iron A, Figs. 1 and 2, 2"x2½"x6" and planed a groove on the side and a tongue on the bottom to fit the slot in the shaper-table. On the side I also planed a diagonal groove near the end and put in a tool like a side tool with a screw (not shown) to adjust it for width of key. In front of the cutter, a spring was placed to hold the keys against the back of the groove. This rig I fastened to the shaper-table and put a piece of tool steel in the tool-post to push the keys past the cutter. When it was adjusted, the boy was set to work and he brought those keys to size in a comparatively short time. The keys were for an agricultural machine and did not have to fit sideways.

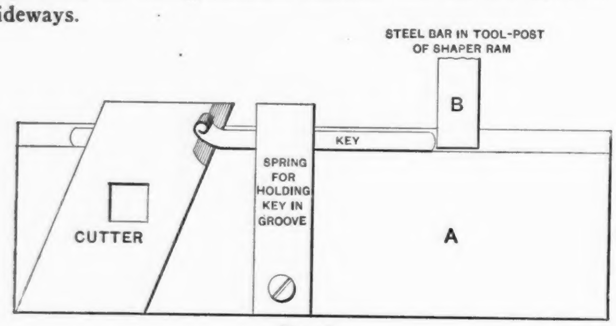


Fig. 1

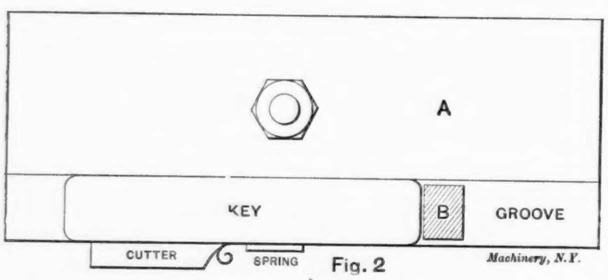


Fig. 2

Rig for Trimming the Sides of Keys.

We often see the assertion: "It pays to advertise." I say, "It also pays to read advertisements." In the November issue of MACHINERY there was an advertisement of an arbor press. We make an agricultural machine that has six drive fits in it. I had been trying for some time to think of some way to do this work faster and also avoid the breaking of so many castings. As soon as I saw that advertisement I said, "There's my machine." I called my employer's attention to it. He ordered the press and now you could not get that press out of the shop for five times what it cost. It has paid for itself many times over in the amount of breakage it prevents.

Mr. Editor, can you tell me why small shops do not practise economy as well as large shops. I venture to say that small shops lose, lend or destroy five times as many small tools, to a man, as large shops. One, and, perhaps the main, reason is the absence of the tool room. Watch a man finish a job in a large shop and you will see him carefully put away every tool. Not so in the small shop. There he will leave them just where he happens to get through with them. I believe a tool room would pay in small shops even if only one man worked in it. I worked for some years in a small shop and quite a number of small tools came under my charge. When a fellow workman wanted to use any of them, I impressed on him the fact that it was a good thing for his health to return those tools as soon as he was through with them. My tools came home; the others were almost always lost.

I believe I have a new idea about selecting gears to cut threads. First, all of the factors in the screw to be cut must be in the lead screw or in the driven gears, whether single or compound. Second, the factors of the lead screw must be contained in the drivers. If you want to cut 2½, 5, 7½, 10, etc., threads per inch, and your lead screw is 5, then any gears that have the ratio 2:1, 1:1, 2:3, 1:2, etc., will effect the desired result. If the lead screw is some other number (not a multiple of 5), then one of the driven gears must be a multiple of 5. To cut fractional threads, reduce the number to an improper fraction and see if the gears and lead screw contain all of the factors of the denominator. Very few lathes will cut 17, 19, 23, 29, etc., because it is not practicable to use these prime factors. If the gears and screw do not contain all the factors, the job cannot be done and it is useless to try. W. A. BRIGHT.

Decatur, Ill.

* * *

HIGH AND LOW PRICES.

Editor MACHINERY:

The experience of Oberlin Smith in purchasing cranes, related in the February issue of MACHINERY, is a common experience to those who have much to do with buying machinery. Such an experience is very perplexing to the buyer in some cases, because there is a strong suspicion that the cheapest offered is much inferior in some unknown way, and yet the price may be due only to superior shop economy and business management. Recently I had to make a selection of an emery wheel stand, of which the specifications were: Capacity for two wheels, cone pulleys for three changes of speed and counter shaft with tight and loose pulleys.

This could not be other than a simple machine, with a spindle, having flanges at each end for the wheels, carried in two bearings supported by some sort of a stand. About the only chance for variation in the design of such a machine would be in the weight and style of stand, the size of spindle in and between bearings and the sizes of the pulleys.

As time of delivery was important, price and date of shipment were asked from a number of makers and twelve responded. The prices varied from $45 to $90, there being one at the lowest and one at the highest price. The lowest priced stand weighed 650 pounds and the highest 900 pounds. One other machine weighed 900 pounds, had two-speed cones, self-oiling bearings and, with the exception of having but two speeds, seemed in every way to be as good as the highest priced one, but was offered at $75. The cheapest self-oiling machine had also two speeds, weighing 600 pounds and offered at $66. The lightest machine, having three speeds, weighed only 500 pounds, but the price was $66. The highest price self-oiling machine weighed 810 pounds, had only two speeds and the price was $80. The cheapest machine was a trifle less than 7 cents per pound. The highest machine weighed 250 pounds more than the lowest, and the difference in price made this increased quantity of metal come at 18 cents per pound. The highest price per pound was 13.2 cents for a $66 machine. I have no doubt that the cheapest machine offered was good enough for all ordinary grindings, but the one selected cost $56, or 8 cents per pound, and is a well built machine, which was preferred because it was better adapted to receive a special grinding fixture we wished to apply.

There is much food for thought in this experience, small as it is, for it was not a special machine which was called for, but a machine which has been built in considerable numbers by all makers of such machinery, and which can require but little in the way of special tools for its manufacture. There has been ample time and opportunity for the makers to find by experience the cost of making such machines, so that to the buyer the vivid contrast between 7 and 13 cents per pound seems to be entirely unjustified. The makers of the $66, or 13-cents per pound machine, have a wide reputation and are one of the oldest established firms manufacturing this class of work, but, after examining and comparing their design and price with others, it is difficult to see what would induce any one to buy their machine when a well built one weighing 200 pounds more, can be had for $10 less, or a self-oiling machine weighing 100 pounds more can be had for the same price. To the buyer it would seem impossible that the great difference shown is due to variation of actual labor and material cost.

From a manufacturer's view the case looks different, as there are several factors which, if combined, would account for the

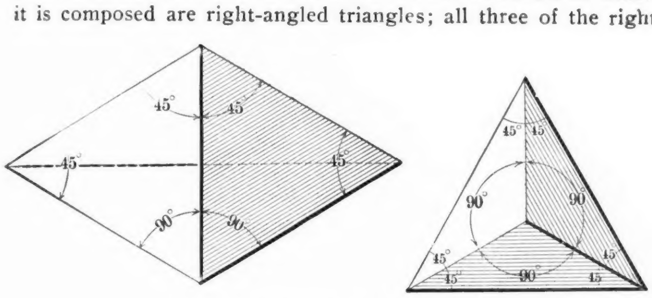
great difference in price. To begin with, it is difficult to tell just what it costs to build and sell a machine. The wages cost and the cost of materials purchased may be found nearly enough, but the proportion of general running cost, advertising, taxes, insurance and office expenses to be charged against a machine or lot of machines manufactured is a factor difficult to determine with any accuracy. After figuring as closely as possible the result must be refined by experienced judgment. When we add to this the difference in design and workmanship, the difference of economy of shop and business management and finally the difference in profit, figured all the way from 15% to 50%, it is not so difficult to see the cause of the great variation in prices. I have no doubt there are some shops among the lot mentioned where they could not have built the emery grinder for $45 and made any profit on it, but others could have built it at a profit of 15% to 20%. The average price of the twelve submitted bids was $68.60 each. One striking fact about the matter is that nearly all the twelve firms in question are thriving and prosperous, which shows that there are many machine buyers or users who are not tempted by low prices. BELL CRANK.

* * *

SQUARING PARTITIONS—IMPROVISED TRAMMEL.

Editor MACHINERY:

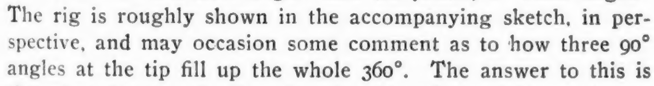
We have recently had to get up a good many cases, having nicely fitted partitions which needed to be exactly at right angles with the back and sides of the cases and at specified distances apart. They were not gained in but held in by sprigs driven in from the outside through the holes of the cases. In order to save time and insure absolute equi-distance, I got up a rig which effected all three adjustments at once and had the great merit of being rapidly and cheaply made and easily used. It consists of a three-sided bottomless pyramid of sheet-iron, having a length of side equal to the distance of the partitions from each other and from the ends of the cases. The three sides of which it is composed are right-angled triangles; all three of the right



For Squaring Partitions.

angles coming together to make what the trigonometrician would call a "trihedral angle" and the joiner, a "solid angle." The rig is roughly shown in the accompanying sketch, in perspective, and may occasion some comment as to how three 90° angles at the tip fill up the whole 360°. The answer to this is that they do not, the lines forming the edges of the angles or the sides of the triangles being fore-shortened, the same effect being observed when one views a box corner "point on."

The use of this rig about doubled the rate at which the partitions could be put in, as compared with the old way of squaring and scribing.



An Improvised Trammel.

We had occasion recently to transfer some important dimensions to fill in on six rough drawings in a repair case where no metric or other measure over a meter long was obtainable, and those which were to be had were of the folding "grasshopper" kind. I took three wine corks, three needles and a long iron rod about a centimeter diameter and made holes crosswise through the corks so that they would slide a tight fit on the rod. Then I stuck the needles, head first, in the axes of the corks, brought the needles to length, "sighted" their points to bring them all in line, and hence parallel with the rod. Finally I set the needles to the shaft centers, etc., keeping them sighted fair, and, without difficulty or inaccuracy, laid out my center points, etc., on the sketch. It was a good example of "fudging," which is an act not always excusable, but sometimes the only thing permissible.

I beg to say that the only difficulty I have ever had with the metric system is one that has no more reason for being connected with that standard than with any other—the abominable folding rule. I have one with lateral springs which hold it nearly straight when new, but it will get "wackly" like others that preceded it. ROBERT GRIMSHAW.

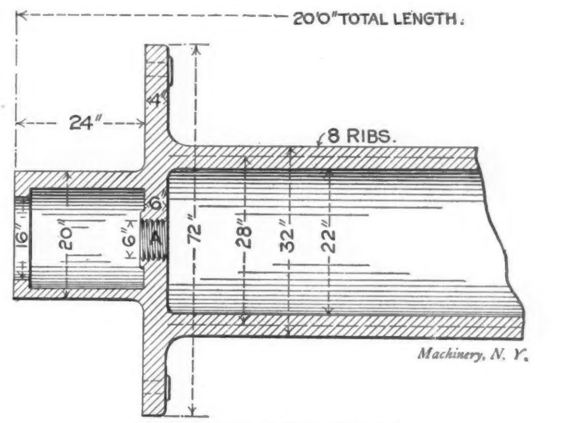
Dresden, Germany.

* * *

A DIFFICULT THREADING JOB.

Editor MACHINERY:

In the shop where I work, a heavy business is done in the manufacture of rolls and rolling mill machinery, besides hydraulic machinery and considerable small work. We have an order for a very large and heavy lathe for turning granite columns which will be completed about May, 1900. The dimensions of the lathe are as follows: Swing 6' 6", center distance 60', total length of bed 86', with a width of 11'. The bed is made in ten sections, five on a side arranged in pairs. Six of the sections are 21' 6" long and four are 10' 6" long. The latter sections sup-



Difficult Internal Threading Job.

port the heads. A chuck is provided for each head and the headstock is 10' 6" long, quadruple geared, while the tail stock is of the same length, but without gearing. Four carriages are provided with compound rests and each carry two tools, one on each side of the column being turned. The feed screws are 86' long with 60' of square thread. The screws have a reverse feed clutch. The total weight of the lathe when completed will be about 150 tons.

The shop is a small one and is not very well equipped for such heavy work, as you will see from the way I had to manage in the following described threading job.

We had to make an accumulator barrel 20' long and thread the end as indicated in the sketch. The hole was six inches in diameter and was to be threaded, nine threads to the inch. We could do all of the machine work very well until we came to the threading part and then we were "stuck" for a time. To tap out the hole would have been an ugly job and the tap would have cost a considerable sum, with the probabilities of never being used again. We could also have done it in a lathe, but only at heavy expense for rests or we could have put on a flange, but the designer would not allow such a construction. I finally managed to do the job at an expense of only about $4 and took about three hours to do it, which bears out the saying that a job often looks the hardest before you tackle it.

I threaded the hole on a Niles boring machine with a belt feed, but had to remove the tool at the end of every cut. I succeeded in cutting a good thread, however, in about three hours, as stated, which, considering the difficulties of the job, was not a bad showing. J. W. BOURN.

Philadelphia, Pa.

* * *

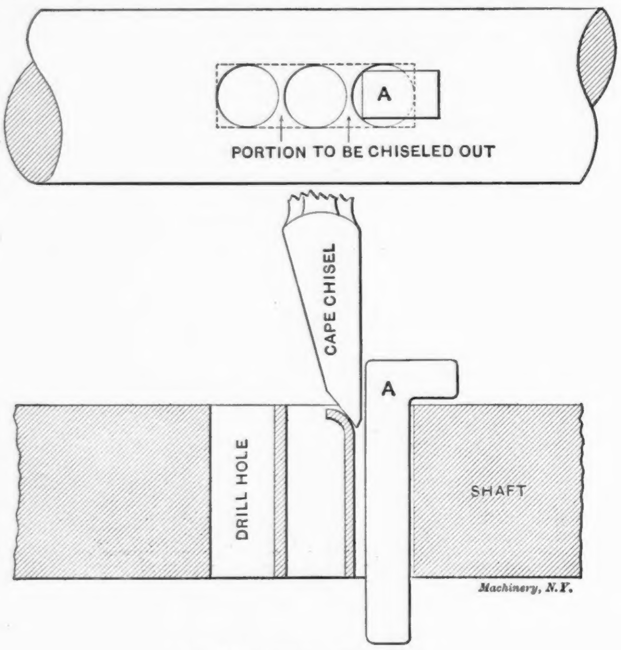
SCHEME FOR CUTTING OUT KEY-WAYS.

Editor MACHINERY:

I used to take MACHINERY and still have the issues for the three years during which I received it. They furnish me with studying matter enough to keep me quite busy and have been a great help in times past. The column "What Mechanics Think" has always interested me and I will contribute a kink

that I have found very useful in my experience. It may help some beginner and also be of benefit to some of the older heads. I think that it is original with me and has been found to be a great labor saver.

It is very difficult to cut the web out between the holes drilled for a slot in a large shaft or even in a small one, where the slot is to be quite narrow; but, by the use of the scheme illustrated



An Aid to Cutting Key-ways.

in the accompanying sketch, the difficulties vanish. I put a square piece A through one of the holes to form a backing for the cape chisel and then a chip can be cut clear through the wall between the two adjacent holes. It is then easy to clear out the sides with a flat chisel. M. E. Bushnell.

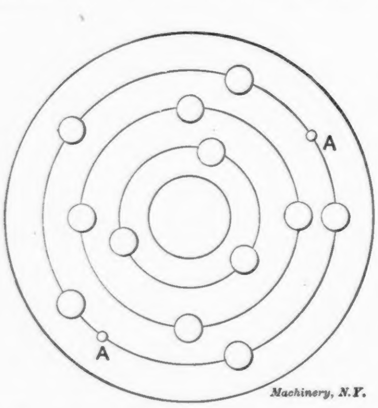
St. Louis, Mo.

* * *

TO CUT MULTIPLE THREADS.

Editor Machinery:

Some time ago a person came to see me and asked if I would cut him some four-threaded screws. He brought me a sample of some that other parties had made for him, but said that he could not use them on account of their being unevenly divided. I devised a method of cutting multiple-threaded screws of two, three, four, five, etc., threads which is very simple and mechanically perfect. I made a plain circular plate to bolt on the face-plate of the lathe and located and held it in exact position with two small dowel-pins, AA. Then a number of circles were scored in same. The circle nearest the center was divided into three parts, the next one into four parts which answers for two divisions as well, the next one into five parts, etc. Holes were drilled in the circles large enough in diameter to hold pins for driving the carrier. To use the plate for cutting multiple threads the carrier is moved from one pin to another until each thread is cut. The plate mentioned is kept specially for multiple thread cutting and can be bolted on by set bolts through the back of the face plate. With this rig there is no counting of teeth, and no wishing you had a wheel or certain number of teeth so that you could divide them evenly. I have been using this method for not less than ten years and have never seen it published in any paper and never came across any machinist who had seen it. James H. Gomersall.



Face-plate for Cutting Multiple Threads.

Germantown, Pa.

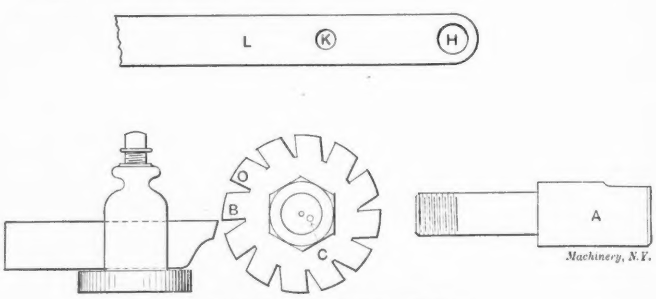
SIMPLE LATHE RIG FOR BACKING OFF MILLING CUTTERS.

Editor Machinery:

Readers of Machinery will remember an article on backing off milling cutters some time ago in Shop Kinks. Now, while that method may have been all right for a few mills, I think the way I am about to describe is better.

The outfit consists of an eccentric arbor and a lever two and one-half feet long. The arbor should be case hardened at the ends and should have a fine thread so that the nut will clamp the mill tight with the least amount of exertion on the part of the man at the end of the wrench. When the eccentric centers are placed in the lathe centers and the arbor turned around to the position shown, a flat must be ground on the large end for the set screw in order that the dog can be put on the way it was before. The hole H of the lever L should make a snug fit on the head stock center and be bolted to the face plate at K in such a way that when the front edge of tooth O is 1/16" from the cutting edge of the tool, the lever will hit the lathe bed. A piece of belt-lacing tied around the lever at that point prevents bruising the bed.

In backing off tooth B, loosen the nut, hold the lever against the lathe bed, run the tool between B and O, bring O against the tool and tighten the nut. When the nut is tightened it will lift the edge of O about 1/16" from the tool. Move the lever up and down, feeding the tool in with the right hand. Repeat this operation for each tooth.



Rig for Backing Off Milling Cutters.

If greater accuracy is desired in the distance the front edge of O is from the tool, make radial lines on the side of the mill against the shoulder of the arbor, from the front edge of the teeth with a scriber. When the lever is against the lathe bed and O is 1/16" from the tool make a mark on the arbor opposite one of these radial lines. After the tooth is backed off, move the mill around and tighten the nut, seeing that the next radial line coincides with the mark. It is well to cover the mill with a solution of copper sulphate (blue vitriol) so as to be able to see when the cut comes to the front edge. Everything about the lathe should be as rigid as possible to insure good work.

I have backed off hundreds of dollars worth of milling cutters in this way and found it very satisfactory. "Win."

* * *

INSERTED CUTTER TOOLS.

Editor Machinery:

In your January issue, "Bell Crank" asks some questions concerning inserted cutter tools: What fault is to be found with them? Why not more used?

A small shop, near Boston, doing general machine work and employing about thirty hands, was entirely refitted about a year ago. A portion of the equipment of small tools consisted of a complete set of inserted cutter lathe tools. Three or four sizes of the ordinary and offset tools were provided; also several sizes of boring, thread and cutting-off tools. They were kept in the tool room and with a solid wrench of proper size were issued only on check. It was the intention to use these tools wherever possible and, consequently, few forged tools of the ordinary patterns were furnished. The test has been a more than ordinarily severe one, as the shop is one in which many of the hands do all the work on a particular job, changing from one machine to another as occasion requires. For a portion of the time, the shop has also been running nights with a separate shift of men, all tools being supposed to be returned to the tool room before closing time. There being a separate man in charge of

the tool room for each gang, it has not been an easy matter to keep the run of the tools, nor to fix responsibility for damage. For these reasons a man seldom has the same tool twice in succession and, therefore, takes less care of it than if he used it continuously. At the present time those of the above tools still in the possession of the shop, a number having mysteriously disappeared, are in about as good condition as the day they arrived. That they are not in just as good condition is due to wear and tear and the inability of man to create a "fool-proof article." Some of the lathe tools have the set screws somewhat bent, with the heads a little out of shape and, in one or two cases, the nibs under the cutters broken or ground off. These things affect but little the value of the tools. The cutting-off and thread tools are as good as ever. So much for the holders. Concerning the cutters, the expense for self-hardening steel has been greater than it ordinarily would be because of the necessity of re-grinding the cutters each time the tool changes hands or else, because of each man having his own set of cutters. With the thread and cutting-off tools such has not been the case, but trouble has been caused by the "blockhead" who used up a cutting-off tool blade, trying to use it upside down in the holder. He explained the trouble by saying: "T'ain't no good; ain't got no clearance." The same hand decided that the thread tool angles were not correct and succeeded in ruining several cutters before he was discovered.

Regarding the comparative cost of forged and inserted cutter tools, I cannot give the actual figures; but, as the inserted cutter tools supplant a much larger number of ordinary tools, the first cost must be less. The time occupied in tool dressing must more than offset the cost of self-hardening steel, while the grinding time will be considered as equal since, if the plain inserted cutter tools take more grinding than an equal number of similar forged tools, the cutting off and thread tools certainly take less.

As "Bell Crank" says, the inserted cutter tool is not as stiff as the forged one, nor can it be used so well in corners, nor substituted for broad faced or side tools. The thread tools, as I know them, can not be used as close to a corner as the forged ones. Outside of this, I see no objections that can be raised by the workman. It may be well to add that now, near the close of the year's use, we have a very complete set of forged tools which have been worked in little by little for special jobs, and are now used together with the cutter tools, both kinds being apparently equally popular. I believe that, as the cutter tools become better known, they will gradually supplant the older ones; for a man likes best the tools he is used to and most of us were "brought up on forged tools." However, the apprentice of to-day, by using the two side by side, will like one as well as the other and, in future, will be content with which ever one is given him.

W. G. R.

* * *

ABOUT LATHE AND PLANER TOOL HOLDERS.

Editor MACHINERY:

In reply to Bell Crank, in the January issue of MACHINERY, would say that I introduced the Armstrong tool holder in two places, both jobbing shops, and, in the first case, the initial tool was watched closely by the proprietor, as I had recommended it very highly. Two pieces of tool steel 4" × 1" × 72" were the test pieces. These were made from the same billet and both were annealed at the same time. One of these pieces was put on a 32" planer with the Armstrong tool and the other was put on a 60" planer with a genuine Mushet tool. The man running the 60" machine was a "hustler" and prided himself on what he could do with this tool, which he kept for special occasions. Both planers ran at the same speed and the clamping of the pieces on the planer was the same. The total time required on the 60" machine was 8 hours and on the 32" machine 5 hours. This result spoke volumes for the tool holder and its steel which, in my estimation, is the "finest of the fine." Still, even after this demonstration I have been informed that, since I left, they do not use tool holders any longer. The steel required is high priced and a little of it costs a great deal so that, each time you put in a requisition for steel, you are confronted with the question: "Is that steel all gone?" This, in itself, is enough to make a man wish that he had not said anything about tool holders and to cause him to neglect them and let them die out slowly.

It is one of the hardest tasks in the world to convince some people of what is to their own interest. They only seem to see the cost of tools or improvements and ignore the fact that they are deriving any benefits; or, if they see any benefit, they attribute it to some other cause, such as their fine management of finances, but never to the improvements made in the shop. They consider that they could have got along as well without these, but wanted to humor the man in charge.

Now as to the difficulties with the tool holders. I find that, when a tool breaks, it does so just inside the holder and, after a time, the holder is rounded in front as shown in the sketch at A, Fig. 1. The holder does not then support the cutter as it should and each successive break moves the rounded part further back. Finally it gets so far back that tightening the screw breaks the cutter. It is rather a tedious job to straighten out the bearing and, even then, it does not give satisfaction for, when the cutter is inserted and screwed down, there is a small space between it and the holder, into which the cuttings find their way. The first thing you find out, in such a case, is that your tool is choked.

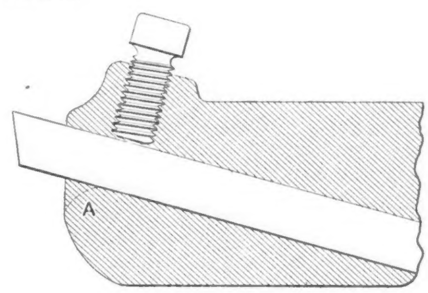
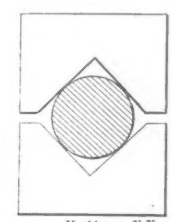


Fig. 1.



Machinery, N.Y.

Fig. 2.

Another source of trouble is the set screw which is generally too small and soon gets upset on the end. You cannot remove it without annealing and drilling it out; but, in spite of these drawbacks, they are a great improvement over the forged tool and, in the hands of good men, they give very little trouble. My foregoing remarks were in regard to men who never think that a screw might work easier if they put a drop of oil on it once a week, who let the cutter project an inch or more from the holder, grind off all the rake and crowd the metal off instead of cutting it, or who let the holder project two or three inches further from the tool-post than necessary. There are more of this class of men than of the other, by a large majority, and it is because of these men and proprietors who will not be convinced, that the forged tool hangs on so long.

If you are given two ordinary tool holders, a straight and an offset cutting-off tool holder, one 1½" round boring bar holder, one 1" round boring bar holder with a bar 18" long, about three round boring tools ½" and ¾" diameter 12" long, with a holder for same as shown in Fig. 2 and steel for the holders, you need not fear very many jobs that are done in a job shop on a 24" lathe. One hour a week will more than suffice on the part of the tool dresser as I should never bother him with cutting off the steel for the holder, but would do this at the emery wheel to avoid spoiling the steel; for, if the steel happens to be soft or not what it should be, the manufacturer could find no fault with me for misusing it, although I do not have much trouble from this source.

A. MERTES.

Emsworth, Pa.

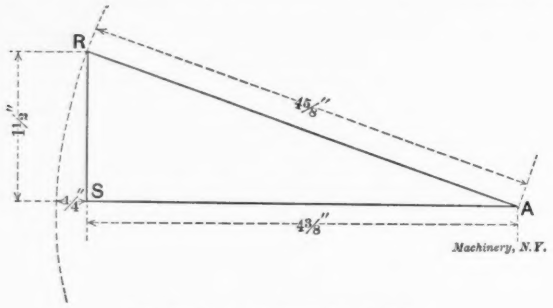
* * *

METHOD OF FINDING HYPOTHENUSE OF RIGHT-ANGLED TRIANGLE FOR A GIVEN LIFT IN A MACHINE.

Editor MACHINERY:

I was interested in the article, "A Comedy of Errors," by W. H. S., in the January issue, especially in that part that concerns the 1¾" lift from the 1½" arm of the bell crank lever. I am afraid "Jones" could not get it with those wonderful proportional dividers, even if he had been fortunate enough to own a pair. I suppose the lift could be obtained by the "cut and try" method, but I herewith send sketch describing a ready means of finding the length required in this or any similar case. By inspection, we find two essentials; that is, the short arm of fixed length—1½" and the excess of length of hypothenuse over that of the altitude—¼". To find the radius that will describe an

arc passing through R and pass beyond the angle S exactly ¼", we proceed as follows: We square the length of arm 1½" = 2¼", add to that the square of the distance marked ¼" = 1/16", divide that sum by the ¼", and divide the quotient by 2, which



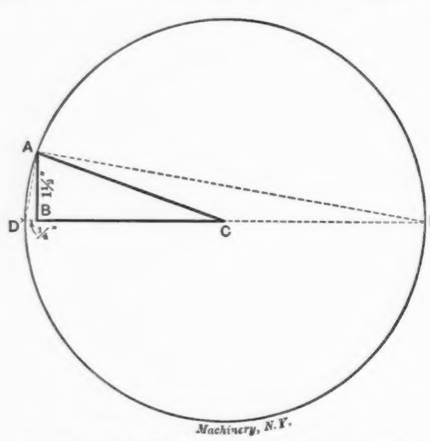
To Find the Lift Given by a Link.

gives the radius required. By calling the arm C, and the ¼" distance D, the formula would be

$$R = \frac{C^2 + D^2}{2\,D}$$

Oneonta, N. Y. WM. NEWTON.

[Another method for finding the required length of link is given in the following, which is not as simple as the one given by our correspondent, but of interest as it is a different solution of the problem and one that may be found useful in other ways. Consider the triangle ABC as being within a circle with the vertex C at the center and the right angle B at a distance of ¼" from the circumference. The side BC, being extended in each direction, forms a diameter of the circle or the line DE. Connect AE and AD and



Another Method for Finding the Lift of a Link.

we have the triangle DAE, which is a right-angled triangle, since it is inscribed in a semi-circle with the diameter as one side. Therefore AB is a mean proportional between the segments DB and BE, being a perpendicular drawn from the right angle to the hypothenuse. Hence,

BE: 1½: 1½: ¼
¼ BE = 2¼
BE = 9 inches.

The diameter of the circle is then 9 + ¼ = 9¼ inches and AC, the length of the link, must be ½ of 9¼ or 4⅝ inches since it is a radius of the circle. The length of the distance BC is 4⅝ —¼ = 4⅜ inches.—Editor.]

* * *

SOLUTIONS AND SUGGESTIONS TO THE PROBLEM IN THREAD CUTTING.

Editor MACHINERY:

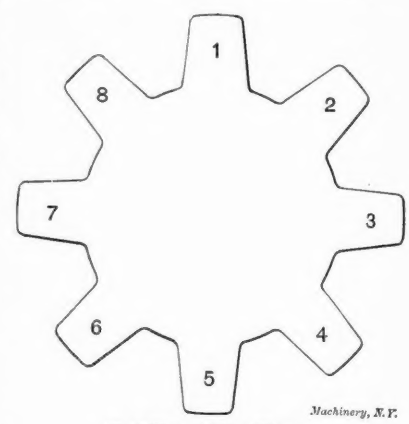
Referring to the practical problem in thread cutting given in the January issue, I would say that with the gears arranged according to the sketch, the lathe will cut a thread having one inch pitch, which was the pitch required. By changing the reverse lever a thread of the same pitch would be cut, but it would be just the reverse of the other. The tumbler gears, being only intermediates, cannot change the ratio, but they simply reverse the direction of the thread cut. To obtain eight parallel threads it is only necessary to divide the 64 T gear into eight equal parts by marking every eighth tooth with chalk and also putting one mark on the 32 T between two teeth. Now cut one thread and then pull the belt until the mark on the 32 T gear corresponds with a mark on the 64 T gear. Drop the quadrant until the 32 T gear clears the 64 T gear and pull the belt around until the next mark on the 64 T gear corresponds with the mark on the 32 T gear when the gears can be brought into mesh with the marks corresponding for cutting the next thread. The operation can be repeated until all the threads in the circle are cut.

I think that Mr. Johnson must have made a mistake in his divisions and if he will examine the threaded pieces, he will undoubtedly find the lead on both the right and left screws the same, the only difference between the two being that one has eight threads and the other nine. H. BRESCH.

Covington, Ky.

Editor MACHINERY:

I will endeavor to throw some light on the difficulty of Mr. Edward O. Johnson, as mentioned in his letter in the January issue of MACHINERY. As I understand it, the worm to be cut was like that shown by the end view in the sketch, consisting of eight parallel threads. To cut such a worm, we will assume, for an example, that it is 10" long and will set the lathe carriage at a certain point and run 10", and cut No. 1 thread. Then, to cut No. 2 thread, unlock the split-nut and run the carriage back 10⅛" and again lock with the lead screw. When the thread is finished, run the carriage back 10⅜" and finish No. 3. This operation is to be continued until all the eight threads are cut.



End View of the Worm.

On the lathe in question, it saves disconnecting the gearing as Mr. Johnson did. If he wished to make the divisions by disconnecting, he could have divided the large gear into eight parts and then mounted a pointer at some point and thus have made his divisions without the possibility of an error.

Rockford, Ill. A. E. PHILLIPS.

Editor MACHINERY:

I note the diffifficulty of Mr. Edward O. Johnson, in his "Problem in Thread Cutting," in the January issue of MACHINERY, and as the samples are not within my reach for inspection, I advance a suggestion rather than a "correct solution," such as the writer asks for.

Let us first consider the principle relating to the gearing of this special instance and, if found correct for the right hand thread, surely it must be correct for the left hand thread as well. We find that the 37 T gear on the latter spindle corresponds to the 37 T gear on the reversing spindle. Therefore they are equal or 1 for 1. It matters not what the tumbler gears are, whether 10 teeth or 100 teeth, nor even 1 of each, as they are only for reversing motion. We further find that Mr. Johnson used a 64 T gear on the spindle which, in turn, drove the 32 T gear of his compound 32 T and 128 T gear which was mounted on the stud. From the combination we get the following:

$$\frac{64 \div 32}{128 \div 32} = 1 \div 8$$

and with the lead screw 8 threads to the inch, we have the lathe geared for 1 inch pitch. We can cut one thread at a time by using the same thread in the lead screw either by running the lathe backwards, catching the thread of said lead screw on even inches, or by stopping the lathe, throwing out the apron nut and measuring back.

Where Mr. Johnson failed, was in loosening his special gear and trusting to re-mesh his 64 T spindle gear, eight teeth in advance of his former mesh. This, Mr. Johnson seemed fortunate enough to accomplish in right hand threading, while he failed in the left hand threading. The error was in taking out the supposed slack in the train of gears for left hand cutting. Mr. Johnson lost a tooth which made him advance the gear only 7 teeth instead of 8 teeth, as he should have done. The 64 T gear being divided by 7 = 9 times (or threads) + 1 tooth extra in the spindle gear. This slight variation one would hardly notice in cutting threads by the slipping gear method.

If Mr. Johnson, after finishing one thread, had measured $\frac{1}{8}''$ so as to catch the other thread in the lead screw, I am of the opinion that he would have had 8 threads on both the left and right hand threads. F. T. MILLER.

Washington, D. C.

Editor MACHINERY:

An article appeared in the January number of MACHINERY entitled "A Practical Problem in Thread Cutting," on which I will offer one or two suggestions. In the first place, I don't see why Mr. Johnson found it necessary to disturb his gearing, under the condition given, after once setting it. He has an 8-pitch lead screw on which to cut an octuple thread; all that would be necessary, when changing from one thread to the next, would be to throw out the split nut on the lead screw and move the carriage ahead or back one thread and drop in the nut again. In my opinion the reason why he cut 9 left-hand threads while only 8 right-hand, was owing to the tool and not to the lathe. The tool did not have clearance enough and hence was crowded back so that it turned slightly in the holder or tool post. The result would be as shown in Fig. 1, in which 1, 2 and 3 represent three perfect teeth on a larger scale than the example to more clearly illustrate it. A and B represent the distance from a point in the finished thread to a corresponding point in the first cut in the next thread. In this case it would be $\frac{1}{8}''$. Now, after finishing thread No. 1, the tool is moved ahead $\frac{1}{8}''$ and the cut started. When the thread is finished, it will be found to have followed the dotted line and the tool will have

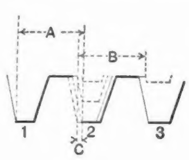


Fig. 1.

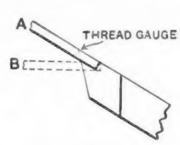


Fig. 2.

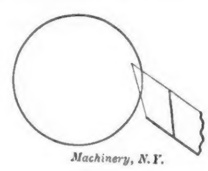


Fig. 3.

been crowded back a distance equal to C. When the tool is moved ahead $\frac{1}{8}''$ for the next thread, instead of coming directly in the center of 3, it falls a distance equal to C nearer the side toward thread 2 and, as a result, at the end of the eighth thread he has lost enough to cut another thread. This result is something out of the ordinary run, as it will generally be found to be more or less than 1 thread.

"Bell Crank," in the same issue of MACHINERY, wants to know the reason why inserted cutter lathe tools are not more extensively used. In my experience I have found that prejudice against them by the working men is the principal reason why they are not used. I have used them for several years and would not like to go back to forged tools again, as I find I can do better and more work with the inserted cutter. While on the subjects of threads and inserted cutters, I will point out one fault into which nearly all machinists fall in grinding a tool to cut a V thread with inserted cutters. They will try their thread gauge on the tool as at A, Fig. 2. Now, by referring to Fig. 3, it will be seen that the line passing through the center of the work is not on a line with the top of tool and, by trying your thread gauge on the tool, as at B in Fig. 2, you will find that the tool is not ground at a small enough angle. The thread cut with it will, therefore, cause the thread in the nut to bear only on the point. B. L.

* * *

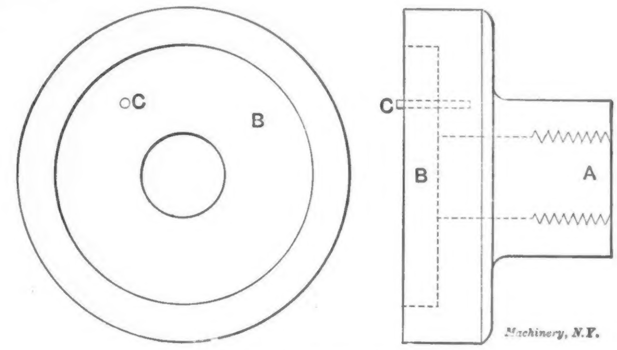
A CHUCK FOR BORING GEARS.

Editor MACHINERY:

It was through seeing a similar device described in MACHINERY that I made the device illustrated herewith for boring small gears. During the past year I bored over five hundred small gears and will have at least three hundred to bore during the coming year. As the work had nearly ruined the chuck jaws, I rigged up this device to save the chucks and also to save time in chucking the work. A female shaft coupling was taken and bored and threaded for the lathe spindle nose as shown at A and was then screwed on the spindle and counterbored at B to a size that would let the gears slip in nicely. A hole was drilled and tapped in the flange at C and a pin screwed into it to drive the gears by the spokes. C. A. F.

Brandon, Man.

[From personal experience we can state that the above simple scheme is one well worth adopting where a number of pieces, similar to the gears mentioned, are to be bored accurately. The parts, of course, have to be all of the same external diameter. This scheme is in reality only a modification of the step-chuck that is much used by watchmakers and repairers. Instead of having only one recess bored on the face of the chuck, a num-



Chuck for Boring Gears.

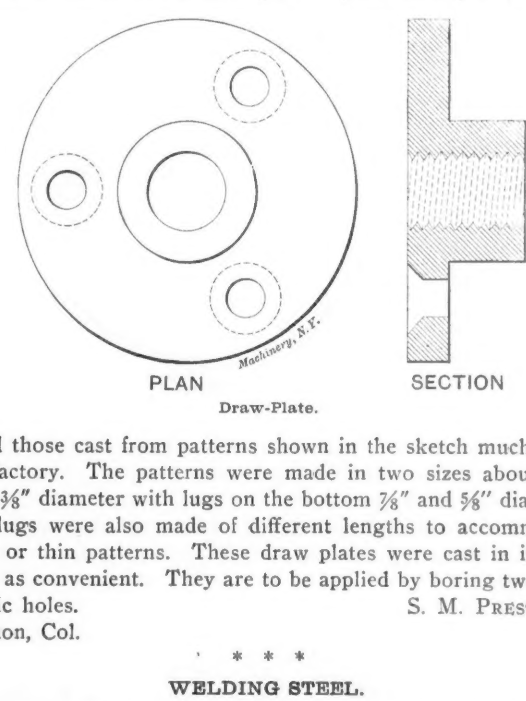
ber are bored which give it the step appearance, hence the name. To provide for all the sizes required, duplicate chucks are provided which have the same number of steps but with the sizes intermediate between those of the preceding chuck. By a judicious arrangement, in a set of chucks nearly every size of watch wheel met, can be handled.—Editor.]

* * *

A DRAW-PLATE FOR PATTERNS.

Editor MACHINERY:

The question by J. T. B. in regard to draw-plates and your answer to same on page 159 of the January issue of MACHINERY reminds me of some I made while in the pattern shop and which were more convenient than any others I have ever seen or know of. These draw-plates are reproduced in the accompanying sketch. Previous to getting them, we had been using some similar to those shown in Fig. 1 of your description, but we



Draw-Plate.

found those cast from patterns shown in the sketch much more satisfactory. The patterns were made in two sizes about $2\frac{1}{2}''$ and $1\frac{3}{8}''$ diameter with lugs on the bottom $\frac{7}{8}''$ and $\frac{5}{8}''$ diameter. The lugs were also made of different lengths to accommodate thick or thin patterns. These draw plates were cast in iron or brass as convenient. They are to be applied by boring two concentric holes. S. M. PRESTON.

Pinon, Col.

* * *

WELDING STEEL.

Practical steel workers know that with some kinds of steel it is very difficult to make a solid weld, says a writer in "Sparks." From my own experience I recommend, when practicable, a "V" scarf. The end of one of the pieces to be welded should be split; then point the other piece and put them together before placing them in the fire for heating to weld. Heat the steel slowly to an even red, then apply borax, and bring the heat up slowly to nearly the welding heat; then take some soft iron filings and sprinkle them over the steel where it is to be welded; put on more borax if necessary and bring the steel up to the welding heat. By the use of iron filings a stronger and sounder weld can be obtained than by the use of borax alone.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

SPECIAL OFFER FOR SHOP KINKS.

To encourage our readers to send more descriptions and photographs of good shop kinks and handy devices, we will give contributors the privilege of selecting from the appended list of desirable machinists' tools, according to the value of the different devices submitted.

To compete, it will be necessary to observe the following conditions:

1.—All descriptions shall be written on one side of the paper only.

2.—The necessary sketches to illustrate the device shall be made on separate sheets from the written matter.

3.—Tools shall be chosen from the following list, as no option in the selection of other tools can be given.

All contributions to this department will be graded, according to value, into four classes. Contributors will be informed by mail during the month following publication, from which class they may make their selections. Cash payment will be made in all cases, if preferred.

Class	Tool	List Price.
1.	Starrett's No. 9 combination square, 12-inch blade, with center head and bevel protractor	$4.00
	Sawyer's No. 100 surface gauge with 12-inch and 18-inch spindles	3.50
	Slocomb's No. 17 outside micrometer caliper	3.50
2.	Sawyer's No. 39 combination square with 12-inch hardened blade	2.50
	Starrett's No. 56 tool maker's case-hardened surface guage, without auxiliary guides	2.50
	Slocomb's No. 12 internal micrometer caliper with depth gage attachment	2.50
	Starrett's No. 11 combination square, 12-inch blade, with center head	2.00
3	Slocomb's No. 11 internal micrometer caliper	1.75
	Starrett's No. 13 4-inch square, with two blades	1.65
	Starrett's No. 15 universal bevel	1.50
	Sawyer's No. 18 spring tempered rule, 12-inch long	1.25
4.	Starrett's No. 40 screw pitch guage	1.00
	Sawyer's No. 19 flexible rule, 9 inches long	.90
	Starrett's No. 79 outside spring caliper, 4 inches	.75
	Starrett's No. 73 inside spring caliper, 4 inches	.75
	Starrett's No. 83 spring dividers, 4 inches	.75

SUCCESSFUL BELT DRIVE.

In Fig. 1, on page 221, is a diagram of a belt drive in the new shops of the F. B. Shuster Co., New Haven, Conn. It shows the means adopted for transmitting power from the jack-shaft to two main lines of shafting, A and B, one of which drives the upper floor of the shop and the other the first floor. These lines of shafting are at the center of the building, and as the engine house stands near one side of the shop, the jack-shaft is placed in the shop , near that side, that the engine can be belted directly to it. From thence power is transmitted to the upper shaft A, by a belt which passes vertically to two idler pulleys C and D, and then horizontally to A. As vertical belts generally give more or less trouble, it was thought that the weight of the horizontal portion of this belt, together with the pressure of the idler pulley I, would, in a measure, counteract the tendency of the vertical portion to slip on the lower pulley. It would seem that such an arrangement is to be preferred to a simple vertical belt wherever it can be used. Idlers I and D are so placed that the belt is in contact with the driving and driven pulleys for an arc of more than 180 degrees. Power is transmitted to the lower shaft B by a horizontal belt.

JIG BUSHING.

The bushing, of which a half section is sketched in Fig. 2, was seen at the shops of the Bullard Machine Tool Co., Bridgeport, Conn., and is made an easy fit in the body of the jig so that it can be removed and another substituted of different diameter. The upper part of the bushing is larger than the main portion, and is cupped out for convenience in oiling. An oil-hole O conducts the oil to the cutting edge of the drill, and the pin P keeps the bushing from turning. If a bushing of this character should trouble by being lifted out of place through the action of the chips from the drill, it can easily be arranged to lock securely in position.

TWO PROVIDENCE KINKS.

"Retsel" sends a description of two kinks that he saw at the Builders' Iron Foundry shops, Providence, R. I., some time ago and which he thinks well worthy of attention. The first is illustrated in Fig. 3, and is a rig designed to accomplish on the drill-press the work that is generally done with a set of chucking tools in the lathe. He writes: "The result is not as good as attained where the work revolves and chucking tools are employed, but it oftentimes answers the purpose. One end of the piece in which a hole is to be finished is indicated at F. This piece is held in a jig by the clamp G, and it has a hole cored through it somewhat smaller than the finished size. Just above and in line with F is a long cast-iron bushing, which is a part of the jig, and has a hole about ¼ inch larger than the size of the finished hole in F. The tool used is an ordinary end mill, D, which is held in a long extension collet C, of such a diameter that it is a free running fit in bushing E. This collet is suspended loosely by a semi-universal joint B, in the way that a floating reamer is usually supported, and the whole rig is clamped to the drill-press spindle by the split hub A. Since the mill is not held rigidly by the spindle, it is guided in a straight line entirely by the collet C, which fits in bushing E. This keeps it accurately in line, and one cut through an ordinarily smooth, cored hole leaves the hole straight enough for hand reaming. The advantage of an end mill over a drill for this work is that it cuts on the end only, and not on the side, and there is less tendency to " run" than in the case of the drill.

"The next figure shows how they mill grinder boxes and caps for some of the emery grinders that they manufacture. The caps and boxes are milled instead of bored before reaming and they are tongued and grooved to keep them in place. The set of three cutters, A, B and C, shown in outline in Fig. 4, serve for both the lower and upper part of the boxes. The sketch shows them as they appear when at work upon the bottom half of a box, D.

"Fig. 5 comes pretty near killing two birds with one stone. It represents a partial side view of one of these grinders in process of having the boxes milled. It was found that the grinder arms were not rigid enough to stand the heavy strain of the broad milling cut without vibration, and some one suggested casting the caps for the bearings of the grinder between the two arms, as indicated by the dotted lines at A and B, Fig. 5. They would not only stiffen the casting, but could also be milled while milling the lower half of the boxes. This was tried with success, and after the milling, the two caps were separated from the body of the casting by slitting saws."

TWO FROM PENNSYLVANIA.

Fig. 6 is a little sketch sent by Mr. Freeman Knight, Philadelphia, who says it is the proper way to turn up the centers for a large lathe before hardening and grinding. By finishing in this way much time is saved when regrinding the centers from time to time, and nothing is sacrificed in strength.

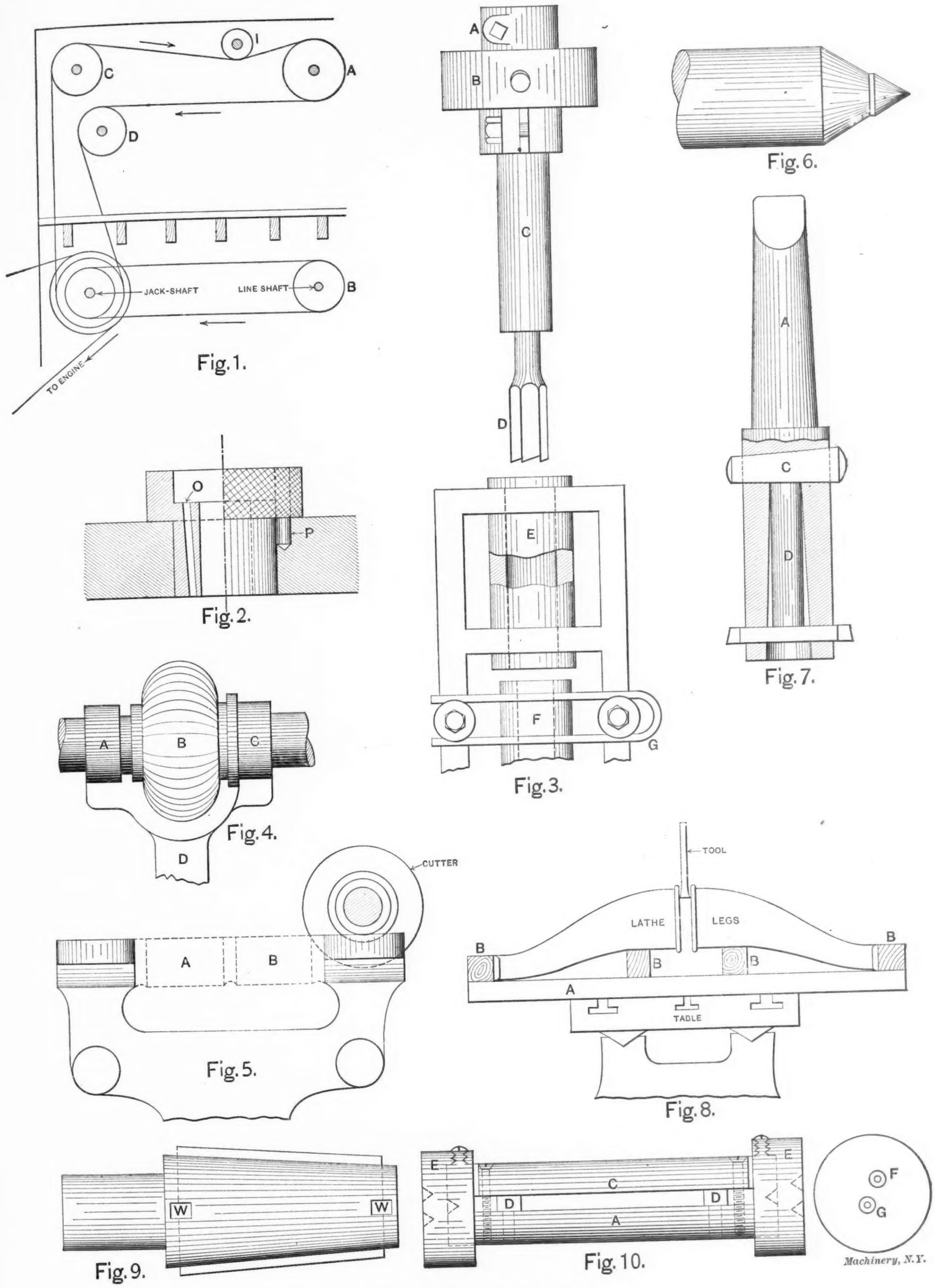
S. V. E., Lemoyne, Pa., writes: "This being the revival season I send you a sketch of a worn-out drill collet, and show how it was revived to do better and more work than ever before. In the sketch (Fig. 7) A represents the body of the collet, B the mushet steel cutter ⅜ inch square and of a length suitable for the work to be done. D is a piece of ⅝" round cold-rolled steel to fill the space between the wedge C and the cutter B. The operation of this revived tool is very plain. Insert the piece D, then the cutter B, then the wedge C, which is driven in the drift hole of the collet, and you have a tool the utility of which is beyond question. The one that came to my notice was a Morse No. 2 socket with a No. 3 shank."

LATHE MAKING IN VERMONT.

Mr. J. R. Rand, Brattleboro, Vt., has a fixture for holding lathe legs, when facing their tops on the planer, which is illustrated in Fig. 8. The fixture is made of neatly planed and fitted square timbers. There are two long timbers, extending across the planer table, one of which is indicated at A, and four cross pieces, indicated by B, B, etc. Suitable clamps are provided for holding the legs in place and the legs are so located that one cut with a planer tool will face off both legs at once. It is not necessary to take a finishing cut because the pressure on the tool is about equal on each side and a surface is obtained true enough for all practical purposes.

TAPER REAMER.

In Fig. 9 is a two-bladed taper reamer used by the C. W. Hunt Co., Staten Island, N. Y. It has a cast-iron body with a slot in which a flat piece of steel is inserted for the cutting edges, as indicated. The steel is held in place by the keys W, W, which fit in notches in each end of the blade. While a double-bladed reamer will not give an absolutely true hole, it answers for many purposes. In Fig. 10 is the arbor employed for turning and grinding the steel blade. The arbor A is slotted to receive the blade and one side, C, of the arbor can be removed when placing the blade in position. The notches in the ends of the blade fit over the blocks D, D, which are pinned to A, and thus the blade is correctly located and is held rigidly in place when C is clamped down upon it. The blade is turned to



A PAGE OF SHOP KINKS.

Fig. 1. A Machine Shop Belt Drive. Fig. 2. Jig Bushing, with Oil Channel. Fig. 3. Drill Press Rig for Rough Work. The Cutter is guided by a long Bushing Figs. 4 and 5. Milling the Boxes and Caps for Grinder Bearings. Fig. 6. Center for Large Lathe. Fig. 7. Drill Collet converted into a Boring Tool. Fig. 8 Facing Planer Legs. Fig. 9. Taper Reamer. Fig. 10. Rig for Turning and Backing Off the Reamer Blade.

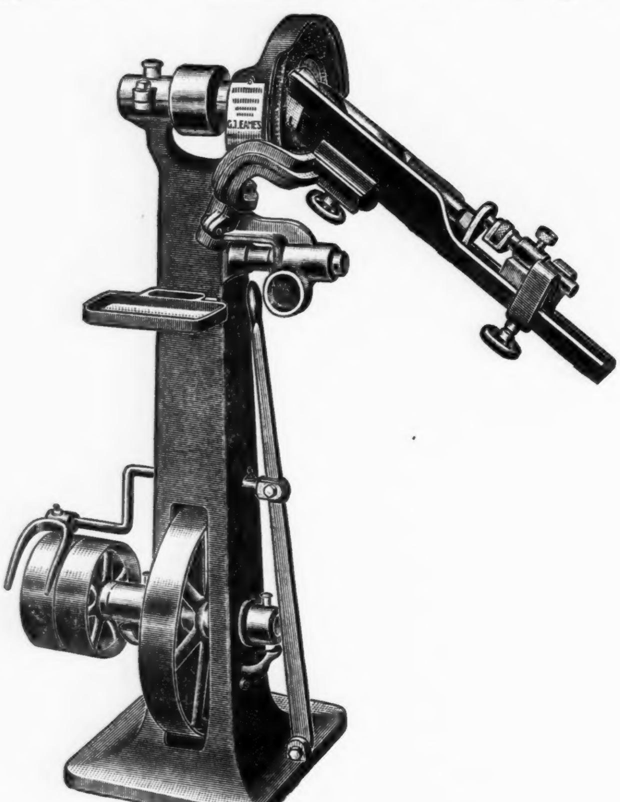
the right diameter and taper with the arbor upon lathe centers, and is then removed and hardened, after which it is replaced and the end pieces E, E, are fastened to the ends of the arbor. These pieces have offset centers, as shown in the end view at F and G, and by grinding the blade with the arbor supported first upon one pair of centers, the emery wheel will grind one edge with the necessary clearance, but will not touch the other edge. Then, by shifting to the other pair of centers, the second edge of the blade will be backed-off, but the first edge will not be injured in any way. One arbor answers for several diameters of reamers, and if it does not support the larger size blades stiffly enough, end pieces, like E, E, can be placed over the ends of the arbor, and by closing up against the blade be made to support it.

* * *

AN IMPROVEMENT IN THE YANKEE DRILL GRINDER.

The manufacturers of the Yankee drill grinder have recently made an important improvement in the oscillating drill holder which entirely does away with gage jaws, calipering arrangements and other devices for correctly locating the axis of oscillation for the drill being ground.

Instead of placing the axis of oscillation in front of the grinding wheel as in other types, the journal on which the drill holder turns is now located beneath the wheel so that if its axis were extended upwards, it would pass through the wheel and intersect the apex of the V-holder slightly outside of the grinding surface. Consequently, a small drill resting in the bottom of the V-holder is held with its point slightly ahead of this imaginary axial line, and the cone on which its cutting edges are



Showing the Method of Supporting the Drill-holder.

ground is of limited size. The angle of the V-sides to the drill holder is such that the larger the drill, the further up it is thrown and the further ahead of the axial line referred to is its point, so that its cutting edges are ground to a cone whose size is directly proportional to that of the drill. Thus any drill, either large or small, automatically takes the correct position relative to the grinding surface and the axial line of the holder, to grind the proper cutting edge. The necessary adjustment required on this machine for grinding any drill within its capacity is, therefore, only one when the clearance is unchanged, and that is the setting of the tail-stock to suit the length of the drill, which adjustment is obviously indispensable.

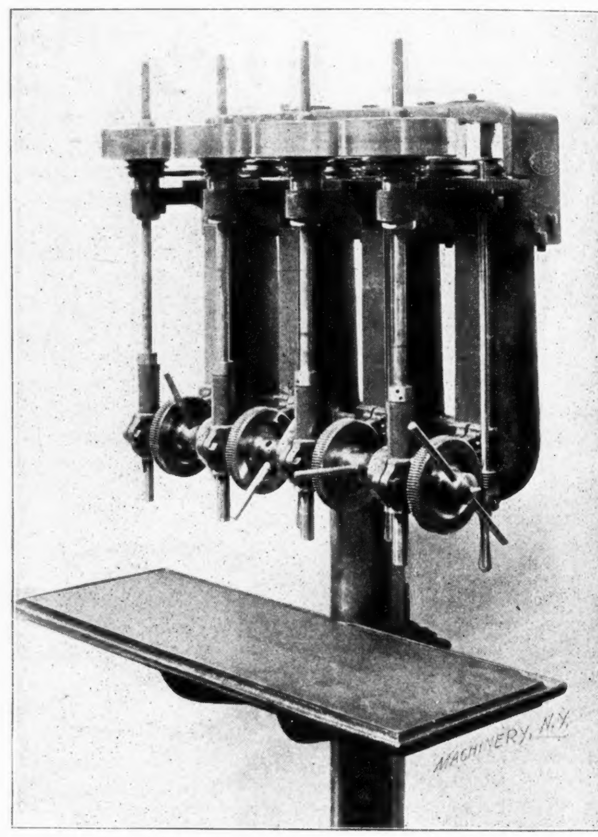
To change the clearance of the drills ground, the drill holder is made with its under surface curved and fitted to a seat of corresponding shape. A hand-wheel and screw, shown beneath the holder, hold it to the seat. By loosening the hand-wheel the drill-holder can be adjusted for any desired clearance. The clearance having been adjusted, it holds good for the grinding of any sized drill within the capacity of the machine (1/8" to 2 1/4"), without resetting.

The Yankee drill grinder is now manufactured by the Fuller Mfg. C., Kalamazoo, Mich., successors to the G. T. Eames Co. of the same place.

* * *

A FOUR-SPINDLE SENSITIVE DRILL.

The four-spindle sensitive drill shown in the half-tone is made with sliding heads which have a vertical adjustment of 12". The countershaft is attached to the base to prevent the belt vibration disturbing the action of the drill spindles. The pull of the belt does not come on the spindles, but is taken by a quill having a steel rack and pinion for the feed motion. Each spindle has an independent stop-motion, so that any spindle may be thrown in or out of action without stopping the machine.



Automatic Feed Applied to Sensitive Drill.

Adjustable stop-collars are provided for limiting the depth of holes drilled. An automatic feed motion can be provided when desired, which has an automatic stop. The stop can be so adjusted that it will trip at any desired depth of hole and allow the spindle to return automatically to its upper position. The spindles are 7/8" in diameter and are bored for No. 1 Morse taper.

The table is counterbalanced by a weight inside of the column and has a vertical movement of 32". The spindles have a vertical travel of 4", so that the extreme distance between the spindles and table is 36". This sensitive drill is manufactured by the George Burnham Co., Worcester, Mass.

* * *

The 10-inch Brown segmental wire-wound gun is finished after nearly three years work. It is expected to be the most powerful gun ever made, as the initial velocity of a 575-pound projectile fired from it, is calculated to reach a velocity of 3000 feet per second. The gun contains a large number of segments held together by over seventy-five miles of square wire wound so that the segments are under heavy compression. The advantages claimed for the built-up form are that for a given caliber, the gun can be built much cheaper and lighter than by any other process.

LESSON FOR MACHINISTS.

BY

THE UNITED CORRESPONDENCE SCHOOLS.

154, 156, 158 FIFTH AVENUE, NEW YORK.

These lessons are not intended to enter too deeply into the subjects treated, and mathematics will be simplified and omitted whenever possible. They will take up such points as machinists and others frequently meet in their work and with which many of them have found difficulty

The readers of MACHINERY are invited to answer the questions and solve the examples in these examinations and to send their replies and solutions to The United Correspondence Schools, 156 Fifth Avenue, New York. Their work will be carefully examined, corrected, and returned, just as if the senders were regular students of the Schools. The Schools will also be pleased to answer any questions concerning the following lesson. Write your name and address on all matter sent to the Schools, in order to insure the prompt return of the work.

THE WORM AND WORM WHEEL.

The Pitch Lines–Pitch of Worm and Wheel–Properties of Teeth and Threads–Sizes of Blanks–The Helix–Proper Angle for Cutting the Teeth of Worm Wheels.

Knowing the method of calculating the diameter of a worm wheel, as well as the dimensions of the teeth, it becomes an easy matter to ascertain the exact size of the blank from which the worm wheel is to be made.

Since the threads of the worm are at an angle and each tooth of the wheel is in contact with a thread of the worm throughout one entire revolution of the latter, it is evident that in order to obtain contact along the whole length, the teeth on the wheel,

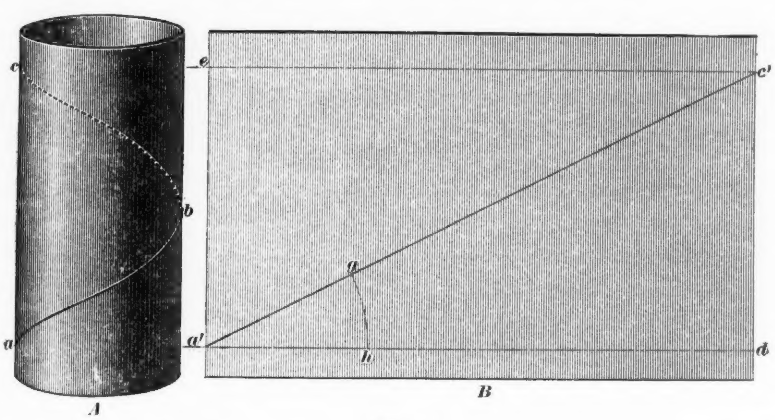


FIG. 2.

instead of running straight across parallel to the axis about which the wheel revolves, like in a spur gear, must slope over at an angle which depends upon the pitch of the threads and the diameter of the worm.

The curve formed by the threads of a worm is the same as the curve formed by the threads of any screw having the same pitch as the worm. This will become clear when it is observed that when cutting a screw or a worm in a lathe, the screw revolves uniformly while the tool with which the thread is cut moves uniformly in a straight line, and, therefore, if the relative velocities remain unchanged each thread will have precisely the same curve no matter how many threads may be cut. The curve of the thread cut in this manner is called a "helix."

A helix is, therefore, the curve traced by a point which moves around a cylinder and at the same time advances uniformly a certain distance along the length of the cylinder. The winding curve, or helix, thus produced is shown at A, Fig. 2. The curve *abc* makes one complete revolution around the cylinder while traversing the vertical distance *a c*. The distance *a c* is the pitch of the helix and this distance is equal to the distance that a point on the pitch circle of the worm wheel moved by the worm when the latter makes one complete revolution.

Let us now investigate the method of finding the angle of the helix *abc*, since this is the angle which the teeth of a worm wheel must have if the diameter of the worm at the pitch line were equal to the diameter of the cylinder shown in Fig. 2, and the pitch of the thread were equal to *a c*, the pitch of the helix shown on the cylinder.

Let us first cut the cylinder vertically along the line *a c* and then flatten it out, as shown at B, Fig. 2. We see that in this position the helix *a b c*, instead of being a curve, becomes a straight line *a' c'*, and that the distance *d c'* is equal to the pitch of the helix or a c, and the distance a' d is equal to the circumference of the cylinder. This will always be the case, irrespective of the diameter of the cylinder, and of the pitch of the helix; therefore, to find the angle of any helix draw a line *a' d*, and on it lay off a distance equal to the circumference of the cylinder.

At the point *d*, erect a perpendicular *d c'*, and on this perpendicular lay off a distance equal to *a c*, the pitch of the helix. Then draw a straight line *a' c'* and the angle *c' a' d* is the angle of the helix, and is, therefore, the angle that the teeth of the worm wheel must be cut in order to work properly with a worm having a diameter equal to the diameter of the cylinder and a pitch equal to that of the helix.

The circumference of a cylinder, being a circle, may be found from the following: The circumference of a circle 1 inch in diameter is 3.1416 inches, and the circumference of a circle varies directly as the diameter. Therefore, we have the following rule.

To find the circumference of a circle when the diameter is given.

Multiply the diameter of the circle by 3.1416.

Example.—Find the circumference of a circle 10¼ inches in diameter.

Solution.—By the rule, we have circumference $= 10\frac{1}{4} \times 3.1416 = 10.25 \times 3.1416 = 32.2014$ inches. Ans.

In the case of a worm, the diameter of the cylinder should always be considered equal to the diameter of the pitch circle, which is twice the distance from r to p' l' in Fig. 1.

Example.—At what angle should the teeth of a worm wheel be cut, if it is to work with a worm whose pitch diameter is 4 inches and the circular pitch of whose threads is ¾ inches.

Solution.—According to the preceding principles, first find the circumference of the pitch cylinder. The diameter being 4 inches, its circumference $= 4 \times 3.1416 = 12.5664$ inches. Draw a horizontal line 12.5664 inches in length. From one end of this line, draw a line at right angles to it and make this line equal to the pitch $= \frac{3}{4}$ inches. Draw a line from the other end of the horizontal line to the free end of the second line drawn, thus completing the triangle. The angle between the horizontal line and the last line drawn is the angle at which the teeth should be cut. Ans.

EXAMINATION 1.—Continued.

11. What kind of a curve is formed by the thread of a worm?
12. What is a helix?
13. How is the distance dc', Fig. 2B obtained?
14. What form will the helix have when the cylinder is flattened out as in Fig. 2B?
15. Show by a sketch at what angle the teeth of a worm wheel must be cut if it is to work with a worm 6 inches in diameter and having a circular pitch of 2 inches.

A NEW EXPANDING MANDREL.

We have received from Mr. C. E. Dowd, of Louisville, Ky., the accompanying drawing and description of a new expanding mandrel which is the invention of Mr. H. Berner, of the same city. The object sought is a mandrel that will give two simultaneously expanding parts and allow disengagement from the work by driving endwise on the core which carries the expanding devices. To accomplish this result it is necessary that wedges shall taper the same way at each end of the mandrel, since a construction in which the tapers are opposed will give trouble when an attempt is made to remove the mandrel by driving on the end. The motion endwise has a tendency to loosen one set of wedges, but it tightens the other set at the same time and thereby gives trouble. The details of this mandrel, which overcomes the trouble mentioned by having the tapers extend in the same direction, are shown quite clearly by Fig. 1 The wedges referred to are shown in the detached view, Fig. 2,

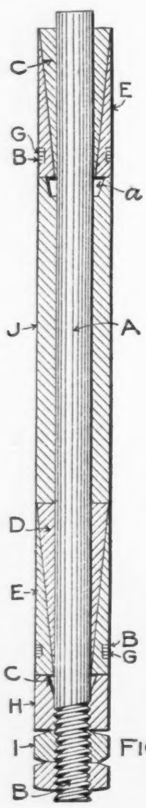


FIG.1

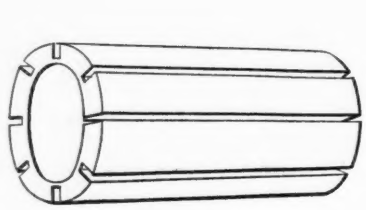


FIG.3

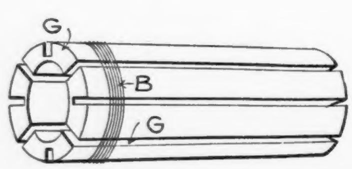


FIG.2

Machinery, N. Y.

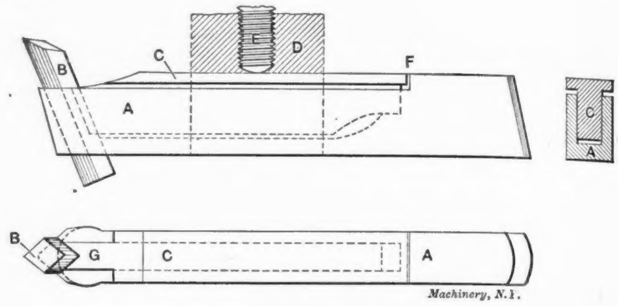
which also shows the coil spring B, that holds the parts together. An expanding shell adapted to go over the wedges is shown at Fig. 3. In Fig. 1 two sets of wedges are shown at E E and the tapered parts over which they fit, D and C. The bushings H and J are relieved so that they may pass over the ends of the tapered parts D and C for a short distance. The nut I is for expanding the wedges and the lock nut is for securing it in position.

When a pulley or similar piece is to be turned, the mandrel is put in the bore and the nut I screwed against the bushing H. The wedges E are forced over the tapered part D and are thus expanded into the bore of the work. Simultaneously, the wedges at the other end are expanded by being forced along by the bushing J. When the work is finished the nut I is loosened and the mandrel loosened by a light blow on A at the threaded end.

* * *

A SIMPLE INSERTED TOOL-HOLDER.

We illustrate herewith a new tool-holder for inserted cutters which is quite novel in its construction, having no set-screws for holding the cutter, but depending on the clamping effect of the screw in the tool-post to hold the cutter in the holder. The holder A is milled out on top for the part C which abuts against a shoulder at F and against the cutter B at G where it is shaped to the form and angle of the tool. The pressure of the cut also tends to tighten the cutter in the holder but not to an extent that in any way interferes with its removal when necessary to change it or to alter the elevation of the point. The feature of elevation of the cutter makes the tool of considerably more value on some classes of work than the ordinary form of diamond point, as the edge of the cutter can be held at the best position for turning without tilting in the tool-post and, at the same time, it keeps the clearance and top rake at the proper angle.



Tool Holder.

Mr. F. W. Roebbel, of the Missouri Pacific Railway, St. Louis, Mo., who is the inventor of the tool, says that he has given it some very trying tests with the most satisfactory results. Driving wheels for locomotives have been turned successfully with it. As is well known, these tires are made of very hard steel which often hardens in "nigger-heads" at points where the wheels have skidded or slipped on the rails, thus making a very difficult material to handle even with the best of ordinary tools.

* * *

NEW TOOLS OF THE MONTH.

Under this heading are listed the new machine and small tools that have been brought out during the preceding month. Manufacturers are requested to send brief descriptions of their new tools as they appear, for use in this column.

Lag-Screw Cutting Machine: Baker Bros., Toledo, Ohio. Designed for cutting the screw-threads on lag screws.

Shaper: Putnam Machine Co., Fitchburg, Mass. Four sizes of this machine are made, ranging from 12-inch to 25-inch stroke. The ram is driven by a crank motion, which gives practically a uniform speed during the cutting stroke.

Tool Holders for Inserted Tools: New holders have been brought out for lathe and planer tools by F. W. Roebel, St. Louis, Mo., care of Missouri Pacific Ry. Shops; Hoggson & Pettis Mfg. Co., New Haven, Conn., and Doolittle & Graham, Meriden, Conn.

Bench Lathe: The Cataract Tool and Optical Co., Buffalo, N. Y. The lathe is 7-inch swing and has an index attachment for milling.

Portable Tool Rack: The New Britain Machine Co., New Britain, Conn. A convenient receptacle for tools, finished work or castings, consisting of two metal shelves or trays supported by a light framework upon castors, so that it is easily moved.

Universal Monitor Lathe: Dreses, Mueller & Co., Cincinnati, O. Intended for general brass work and specialties where it does not pay to make special tools; 13-inch swing.

Power Hammer: Beaudry & Co., 8 Oliver St., Boston, Mass., This hammer has several important improvements, including a new frame which is massive and has a very convenient arrangement of the anvil.

Power Press: The E. W. Bliss Co., Brooklyn, N. Y., have added to their products a double-geared press adapted to a wide range of heavy work. It will cut iron blanks, cold, 12 inches in diameter by ¾ inch thick.

Molding Machine: The Maywood Foundry and Machine Co., 507 Monadnock Building, Chicago, Ill. This machine is portable and is operated by hand power.

Bench Drill: The George Burnham Co., Worcester, Mass. Designed for drilling ⅜-inch holes or less. This company are also prepared to supply a power feed to their sensitive drills when desired.

Twist Drill Grinder: The Fuller Mfg. Co., Kalamazoo, Mich., have made an improvement in the "Yankee" twist drill grinder which they manufacture, whereby the number of adjustments required is reduced.

Engine Lathe: Schumacher & Boye, Cincinnati, Ohio, are building a 28-inch lathe, driven by a motor, mounted directly on the spindle.

Upright Drills: The Cincinnati Machine Tool Co., Cincinnati, Ohio, are building a 24-inch upright drill, with back gears, quick return, and the usual feeds found on such machines.

Multiple Spindle Drills: The Baush & Harris Machine Tool Co., Springfield, Mass.. and the F. B. Shuster Co., New Haven, Conn. Both described in this number.